AUGUST

POPULAR SCIENCE

MONTHLY

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Little Guns That Kill Tanks PAGE 82

How Flames Blast Enemy Troops PAGE 38

THIS COMPLETE, SIMPLE, PRACTICAL COURSE FOR SELF-INSTRUCTION WILL QUICKLY GIVE YOU

a complete mastery of

Mathematics

PREPARE now for an important job in America's busy wartime industries—learn mathematics. Mathematics is the basic requirement of all mechanical and scientific work, and of all business or industry based on science. Without this essential knowledge even the most capable man is left behind while others forge ahead to better jobs, bigger contracts, more money. You need mathematics to understand all technical work, to supervise operations, to improve, speed up and check on your work and the work of others. Such basic training is quickly recognized today and gladly paid for. It singles you out from the crowd and gives you an advantage whether it is a matter of a job, a promotion or a contract.

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ARITHMETIC: Starting with a quick review of principles, this volume presents all the special calculation methods used in business and industry which every practical man should know. Fundamental in all computations in engineering, both military and civilian. Essential methods for rapid calculation such as is needed in firing guns, setting lathes, etc. Systems of measurement and their computation required in machine work. Hundreds of other applications to technical work.

ALGEBRA: Starting with simple practical problems, this book shows you, step by step, how to apply algebraic methods to the most complex problems. Shows how to

(Continued on next page)

An Expert Gives You His Simplified Methods

Mr. Thompson, the author of these books, is not an ordinary teacher of mathematics. He has had many years experience in giving students the kind of mathematical training they need in practical work. He presents each practical method and problem in the clearest and simplest way. He gets right down to the kind of information that you need in your daily work.

Don't let appearances fool you, mathematics is easy. You can get these books on approval and see for yourself how much enjoyment you will have while getting this valuable training and solving interesting practical problems that puzzle your friends and fellow workers. In no time at all you will be tackling with ease the most difficult question on this subject.

MATHEMATICS IS THE INDISPENSABLE FOUNDATION KNOWLEDGE FOR TODAY'S NEW *technical & mechanical* Defense Jobs

THOUSANDS of new jobs are calling for trained men! Every industry is rapidly expanding to meet the needs of our gigantic wartime program. Trained mechanics and technicians are in urgent demand. In many lines there are more jobs than men prepared to fill them.

And in the best of these jobs, the jobs which offer the highest pay and the greatest assurance of steady employment, a knowledge of mathematics is required, because mathematics is the foundation of all technical work. Give yo rself this basic preparation now by this quick, inexpensive home-study method—a complete mathematics course in five volumes.

MATHEMATICS for Self Study

by J. E. Thompson, B.S. in E.E., A.M., Dept. of Mathematics, Pratt Institute

(Continued from facing cover)

solve problems which are involved in all military and industrial work, relating to machines, engines, projectiles, ships, planes, etc. Logarithms and slide rule, and many other practical applications.

GEOMETRY: States clearly all needed facts about plane figures, circles, polygons, etc. Covers all the topics essential in drafting and engineering. It deals at length with angles, triangles, circles, and the many other geometric figures that are basic to engineering design. Sheet metal work, so important in airplane construction, is a direct application of these pr ciples. So also is the laying out of ship hulls, which is the major activity in ship construction. The properties of circles and spheres explained in this volume also apply directly in navigation.

TRIGONOMETRY: This volume makes easy the principles of angles and triangles, shows you how to use tables that explain their functions. Practically every problem in machine work, land surveying, mechanics, astronomy, navigation and range finding is solved by methods of trigonometry. These methods are explained here in the most simple way with actual examples of calculations of height and distance as they are applied directly to the sighting of guns and the determination of the position of a ship at sea, the construction of buildings and fortifications, the cutting of gears, etc., etc. All necessary tables for making these computations are furnished in this book as they are in all the other volumes of this series.

CALCULUS: You will enjoy mastering calculus in this interesting new way and will find it will enable you to solve problems that can be solved in no other way. This branch of mathematics deals with rate problems. It is essential in computation involving objects moving with varying rates of speed. It also enables us to find the most efficient design for any kind of mechanism, engine, or moving vehicle. Typical problems included in this book are the calculation of the velocity with which a man supported by a parachute strikes the ground, the path of a bullet or shell, the work done by expanding gas or steam (which is applied directly in the design of rifles and cannon).

These are but a few of the hundreds of subjects simplified and explained in this complete reading course in mathematics.

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POP. SCIENCE 8-42

POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 141 NO. 2

Mechanics & Handicraft

THE NEWS PICTURE MAGAZINE OF SCIENCE AND INDUSTRY

CONTENTS *for* AUGUST, 1942

News

Automobiles

Home and Workshop

Departments

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Our Cover

INSTEAD of tanks, planes, or guns, this month's cover photograph shows America's greatest war weapon—the flag which symbolizes the national ideals and the national spirit that stand behind all our vast machinery of war and give it its justification and its power. Made by William Morris at Governors Island in New York Harbor, the picture shows the national colors carried by a color guard of the military police battalion at the post. It was taken at noon with the aid of five blue daylight flash bulbs; 1/100-second exposure at f/8.

Published monthly at 353 Fourth Avenue, New York, N. Y., by Popular Science Publishing Co., Inc. Godfrey Hammond, President and Treasurer; R. C. Wilson, Raymond J. Brown, Vice Presidents; F. W. Briggs, Secretary. Entered as second-class matter Dec. 28, 1915, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Entered as second-class matter at the Post Office Department, Canada. Printed in U.S.A.

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WILL ordinary folks own a family plane? No question about it! You could buy one today but for the war. That's only part of the story. There'll be super-luxury liners for air travel. Fleets of flying freighters! You'll see them all in the new America that is just around the corner.

This will be a land that's even more wonderful than the one we're all fighting for today. Its birth is scheduled for the day after Victory. From blueprints already drawn . . . from factories already producing . . . from the hearts and minds of men already building toward it, will come a way of life to dwarf anything we've ever known.

If you had been as close to aviation as we of B. F. Goodrich have been for three decades, you too would realize that miracles are becoming commonplace. From our own laboratories, we've seen developments which helped to give a new concept to flying. Developments such as the first low-pressure airplane tire, a Silvertown that could take the impact of a plane's landing again and again. The first De-Icer, which makes possible year-round flying. Brakes to bring giants-of-the-air to safe, smooth stops. The list of B. F. Goodrich aviation products numbers 80 now . . . and it's still growing, still improving, still probing the future.

Right now, of course, we have that other job to do. The planes we equip today must destroy before they can create. Uncle Sam's bombers, fighters, and trainers have first call on our Silvertown Tires, Expander Tube Brakes, De-Icers, Bullet Sealing Fuel Cells. But, when that famous birthday arrives, the planes of peace will also be supplied with B. F. Goodrich equipment. The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.

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Be a RADIO Technician

J. E. SMITH, President
National Radio Institute, Established 27 years

I Train Beginners at Home for Good Spare Time and Full Time Radio Jobs

More Now Make $30 $40 $50 a Week than Ever Before

Here is a quick way to more pay. Radio offers a way to make $5, $10 a week extra in spare time a few months from now, plus the opportunity for a permanent job in the growing Radio industry. There is an increasing demand for full time Radio Technicians and Radio Operators. Many make $30, $40, $50 a week. Clip the Coupon below and mail it. Find out how I train you at home for these opportunities.

Jobs Like These Go to Men Who Know Radio

The 882 broadcasting stations in the U. S. employ Radio Technicians and Operators with average pay among the country's best paid industries. The Radio repair business is booming now because manufacturers have stopped making new home and auto Radios and the country's 57,400,000 sets are getting older, requiring more repairs, new tubes, parts. Many N. R. I. trained Radio Technicians take advantage of the opportunities to have their own full time or spare time Radio service businesses. The Government needs many Civilian Radio Operators, Technicians. Radio factories employ thousands of trained technicians as they rush to fill millions of dollars worth of Government orders. Think of the many good jobs in connection with Aviation, Commercial, Police Radio and Public Address Systems. N. R. I. gives you the required knowledge of Radio for these jobs. N. R. I. trains you to be *ready* when Television opens jobs in the future. Yes, N. R. I. trained Radio Technicians make good money because they use their heads as well as their hands. They are THOROUGHLY TRAINED. Many N. R. I. trained men hold their regular jobs, and make extra money fixing Radio sets in spare time.

WOMEN HELP WIN THE WAR

Patriotic women can help themselves—help fight the war—by doing a man's job—at a man's pay. The Government broadcasting stations and many branches of Radio will employ women who can qualify as Radio technicians and operators. I will teach you Radio at home in your spare time. Investigate. Mail the coupon.

Beginners Soon Learn to Make $5, $10 a Week Extra in Spare Time

Nearly every neighborhood offers opportunities for a good part-time Radio Technician to make extra money fixing Radio sets. I give you special training to show you how to start cashing in on these opportunities early. You get Radio parts and instructions for building test equipment, for conducting experiments which give you valuable practical experience. My 50-50 method—half working with Radio parts, half studying my lesson texts—makes learning Radio at home interesting, fascinating, practical.

Find Out How N. R. I. Teaches Radio and Television

Act today. Mail coupon now for 64-page Book. It's FREE. It points out Radio's spare time and full time opportunities and those coming in Television; tells about my Course in Radio and Television; shows more than 100 letters from men I trained, telling what they are doing and earning. Find out what Radio offers you. Mail coupon in envelope or paste on penny postcard—NOW.

J. E. SMITH, President
Dept. 2HP3
National Radio Institute
Washington, D. C.

Broadcasting Stations employ N. R. I. trained Radio Technicians as operators, installation, maintenance men and in other capacities and pay well.

Set Servicing pays many N. R. I. trained Radio Technicians $30, $40, $50 a week. Others hold their regular jobs and make $5 to $10 extra a week in spare time.

Loudspeaker System building, installing servicing and operating is another growing field for N. R. I. trained Radio Technicians.

Extra Pay in Army, Navy, Too

Men likely to go into military service, soldiers, sailors, marines, should mail the coupon Now! Learning Radio helps men get extra rank, extra prestige, more interesting duty at pay up to several times a private's base pay. Also prepares for good Radio jobs after service ends. IT'S SMART TO TRAIN FOR RADIO NOW!

I Trained These Men

$10 a Week in Spare Time

"I repaired some Radio sets when I was on my tenth lesson. I really don't see how you can give so much for such a small amount of money. I made $600 in a year and a half, and I have made an average of $10 a week—just spare time."—JOHN JERRY, 1729 Penn St., Denver, Colorado.

Had Own Business 6 Months After Enrolling

"I went into business for myself 6 months after enrolling. In my Radio repair shop I do about $300 worth of business a month. I can't tell you how valuable your Course has been to me."—A. J. BATEN, Box 1168, Gladewater, Texas.

Sergeant in Signal Corps

"I am now a Sergeant in the U. S. Army, Signal Corps. My duties cover Radio operating, maintenance of Army Transmitters and Receivers, operating Teletypes, handling duties of the Chief Operator in his absence." SERGEANT RICHARD W. ANDERSON, U. S. Army (Address omitted for military reasons.)

TRAINING MEN FOR VITAL RADIO JOBS

FREE BOOK HAS SHOWN HUNDREDS HOW TO MAKE GOOD MONEY

J. E. SMITH, President, Dept. 2HP3
National Radio Institute, Washington, D. C.

Mail me FREE without obligation, your 64-page book "Rich Rewards in Radio." (No salesman will call. Write plainly.)

Mr. }
Miss } .....
Mrs. }

ADDRESS .....

CITY ..... STATE .....

Contents (CONTINUED)

LISTEN FELLOWS

We can't all serve in the Armed forces. Men are vitally needed in industry if they have proper training. But whether your place is in the armed forces or in the plants that supply our armed forces with the materials they need, **it is your duty to prepare yourself by training to do your best job for your country.** So give careful thought to one thing—**you can serve your country best now as a trained man and you can then be ready for a real job when the war is over.**

Amazingly Easy Way to get into ELECTRICITY

I'll Finance Your Training

Electricity is the power behind our program. If you are a trained Electrical man **you are needed now—and you'll be needed when the war is over.** This is your opportunity **to prepare to best serve your country now** and **be ready to take your place in the prosperous period when the war is over.** You don't need much money. **"I'll finance your training"**—Then too **I'll help you get a spare time job to earn your living expenses.**

Learn Without Books in 90 DAYS

Lack of experience—age, or advanced education bars no one. I don't care if you don't know an armature from an air brake—I don't expect you to. It makes no difference! Don't let lack of money stop you. Most of the men at Coyne have no more money than you have. That's why I have worked out my astonishing offers.

Earn While Learning

If you need part-time work to help pay your living expenses I'll help you get it. Then, in 12 brief weeks, in the great roaring shops of Coyne, I train you as you never dreamed you could be trained...on one of the greatest outlays of electrical apparatus ever assembled . . . real dynamos, engines power plants, autos, switchboards, transmitting stations...everything from doorbells to farm power and lighting . . . full-sized . . . in full operation every day!

PREPARE FOR JOBS LIKE THESE

Our Employment Bureau for graduates gives FREE lifetime employment service.

Armature Winder
Sub-Station Operator
Auto & Aviation Ignition
Maintenance Electrician
Service Station Owner
Air Conditioning
Electric Refrigeration
Radio Servicing
and many others

AFTER GRADUATION WE BACK YOU UP WITH REAL HELP

Coyne maintains an employment and a consultation department. After graduation your name and qualifications are listed. Then we contact hundreds of employers throughout the country who call upon us for help. In addition to this we send our graduates up to minute reports of developments in the electrical field, and you may call upon us at any time for consultation or employment help. We not only train you for success but do everything in our power to help you win this success when you leave our school. This help continues anytime you need it regardless of how long after you graduate.

Get the Facts

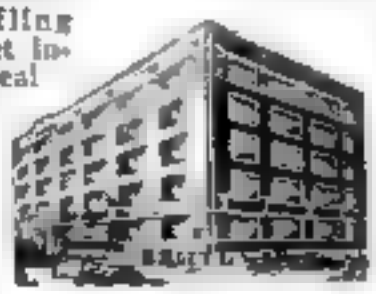
Coyne is your one great chance to get into electricity. Every obstacle is removed. This school is 43 years old—Coyne training is tested and proven. **You can get training first—then pay for it in easy monthly payments after you graduate.** You can find out everything absolutely free. Simply mail the coupon and let me send you the big free Coyne book...facts...jobs...salaries . . . opportunities. I'll send you the stories of many of our graduates who tell you in their own words what Coyne has done for them. This does not obligate you. So act at once. Just mail coupon.

Get this FREE Book

No Books—No Classes

No dull books, no baffling charts, no classes, you get individual training . . . all real actual work . . . winding real armatures, operating real motors, dynamos and generators, wiring houses, etc., etc. That's a glimpse of how we train you for success.

THE HOME OF COYNE



This is our fireproof, modern home wherein is installed thousands of dollars' worth of the newest [redacted] most modern Electrical equipment of all kinds. Every comfort and convenience has been arranged to make you happy and contented during your training.

COYNE ELECTRICAL SCHOOL
H. C. Lewis, Pres., Dept. C2-73
500 S. Paulina St. Founded 1899 CHICAGO, ILL.

H. C. LEWIS, Pres.
COYNE ELECTRICAL SCHOOL
Dept. C2-73
500 S. Paulina St., Chicago, Ill.

Dear Mr. Lewis:
I'm really in earnest. I do want to get ahead. Send me your big free catalog with full particulars about Coyne training and your plans to help a fellow, who hasn't a lot of money, to get ahead.

Name .....

Address .....

City ..... *State* .....

Coming Next Month—

"IT ISN'T THE HEAT . . ." That old bromide is none the less true for being trite. And now scientists, working in a research laboratory to improve clothing for soldiers and war workers, have discovered that it is even truer than we thought. They have found that high humidity not only interferes with the natural cooling system of the human body; on muggy days, our clothing may actually generate considerable amounts of heat by absorbing moisture from the air. Read about it and know why you're sweltering.

TORPEDO BOMBERS are among the new air weapons that are making the battleship look to her laurels as mistress of the sea. They crippled the mighty *Bismarck* so that surface craft could get in for the kill; in engagements all over the world they have upset all the rules of naval tactics. An article tells you what you want to know about these new arbiters of sea power.

BALL BEARINGS smooth the path of our war machines, and make industrial production possible. Have you ever wondered how these steel spheres are manufactured to their less-than-hairbreadth accuracy of size and shape? Story and pictures take you through the process from the metal blank to the assembled bearing.

A MAN'S HOME is his castle these days, in a very real sense, and it's part of your duty to keep your house fit as part of your contribution to the war effort. "Keeping a Roof Over Your Head" tells how to strengthen your first line of defense against the elements, with practical hints on how to look for trouble and what to do when you find it.

PATTERNS OF COLOR, appearing as if by magic on special photographic paper, now guide metallurgists in extracting metals from ores. This new prospecting method, which may speed the production of metals needed for war use, is described and illustrated.

THE BIKE IS BACK, delighting the die-hards who always said that the automobile was only a passing fad. Now that you're pedaling for victory, you'll want to know how to take care of your bicycle and get the most out of it in mileage and pleasure. An article gives you all the dope, even to a check list for your 200-mile servicing.

AERONAUTICAL ENGINEERS have found a versatile new material in "Fairprene," a cotton cloth treated with synthetic elastic compositions. Better carburetors are made possible by its use in molding a gasoline-resisting diaphragm that will remain flexible in service. It also serves admirably for oil seals, valve seats, shock mountings, grommets, couplings, valve cups, gaskets, and other parts requiring a pliable material that can be supplied in exact degrees of hardness, flexibility, or elasticity, with resistance to oils, heat, salt air, weathering, corrosion, and aging.

From the News Editor's Desk

A FIFTEEN YEAR-OLD AMERICAN GIRL has 90 chances out of 100 of eventually getting married, according to figures compiled by the Metropolitan Life Insurance Company. If she is still single at 30, her chances are just half as good. However, a prolonged war, with heavy casualties, would tend to decrease the chances for eventual marriage by disturbing the ratio of men to women of marriageable age. This effect was noted in countries which suffered heavy losses in the First World War.

IF YOU STEP ON A NAIL, the best treatment for your foot is a simple one. Among construction workers at the U. S. Naval Air Station, Jacksonville, Fla., 661 nail-puncture wounds produced an average disability of only six tenths of a day when the following treatment was given: The foot was soaked in hot water for 15 to 30 minutes to dilate the blood vessels and bring an exudation of lymph; an area around the wound was painted with tincture of mercresin and dirt was swabbed out; then the foot was bandaged and tetanus antitoxin was given. Then the patient returned to work, unless the nail that caused the injury was larger than 10-penny, in which case he was laid off for a day or two.

STUDY OF HUMAN HEREDITY would be the purpose of a research institute proposed by Prof. Earnest A. Hooton, famous Harvard anthropologist. It would operate by investigating the personal characteristics and backgrounds of persons about to be married, and then observing their offspring through the periods of growth and maturity. "The research staff would not have to twiddle its thumbs until the infants grow up," Professor Hooton observes cheerfully. "Neither births nor marriages are uncommon."

FOREIGN SUPPLIES OF RICE, cut off by the war, may be replaced by grain grown in the Florida Everglades. Rice growing was started on a small scale in Florida a year ago as a means of providing a cheap feed for poultry farmers. Success of the venture opens the possibility of thousands of acres being devoted to the cereal, creating a new agricultural industry for the state.

KNOWLEDGE
THAT HAS
ENDURED WITH THE
PYRAMIDS

A SECRET METHOD FOR THE MASTERY OF LIFE

WHENCE came the knowledge that built the Pyramids and the mighty Temples of the Pharaohs? Civilization began in the Nile Valley centuries ago. Where did its first builders acquire their astounding wisdom that started man on his upward climb? Beginning with naught they overcame nature's forces and gave the world its first sciences and arts. Did their knowledge come from a race now submerged beneath the sea, or were they touched with Infinite inspiration? From what concealed source came the wisdom that produced such characters as Amenhotep IV, Leonardo da Vinci, Isaac Newton, and a host of others?

Today it is known that they discovered and learned to interpret certain *Secret Methods* for the development of their inner power of mind. They learned to command the inner forces within their own beings, and to master life. This secret art of living has been preserved and handed down throughout the ages. Today it is extended to those who dare to use its profound principles to meet and solve the problems of life in these complex times.

AMENHOTEP IV
Founder of Egypt's
Mystery Schools

This Sealed Book—FREE

Has life brought you that personal satisfaction, the sense of achievement and happiness that you desire? If not, it is your duty to yourself to learn about this rational method of applying natural laws for the mastery of life. To the thoughtful person it is obvious that everyone cannot be entrusted with an intimate knowledge of the mysteries of life, for everyone is not capable of properly using it. But if you are one of those possessed of a true desire to forge ahead and wish to make use of the subtle influences of life, the Rosicrucians (not a religious organization) will send you A Sealed Book of explanation without obligation. This Sealed Book tells how you, in the privacy of your own home, without interference with your personal affairs or manner of living, may receive these secret teachings. Not weird or strange practices, but a rational application of the basic laws of life. Use the coupon, and obtain your complimentary copy.

Use this coupon for **FREE** *copy of book*

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Please send free copy of Sealed Book, which I shall read as directed.

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The ROSICRUCIANS
SAN JOSE (AMORC) CALIFORNIA

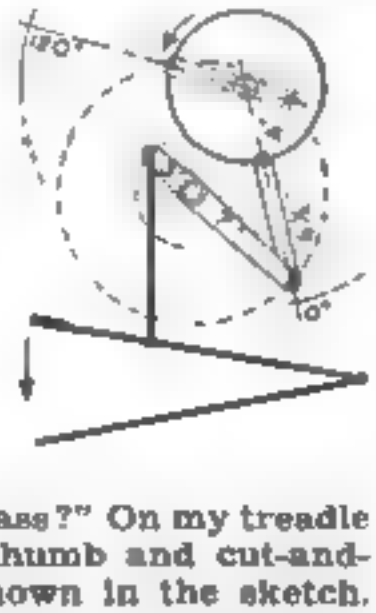
Readers Say:

This Is the Kind of Letter That Makes an Editor Feel Good

I WISH to congratulate POPULAR SCIENCE for successfully creating a new, pleasing editorial style. Informative it has always been. This new manner of presentation makes it doubly attractive. Those clean-cut sketches, photographs, illustrations! Those headings! From the standpoint of magazine values I can name hardly any other magazine which rates in the same class. Yes, something new has been added, and your magazine continues to be well received at this address, you may be sure. Keep up the good work, and thanks!—L. McC., Geneva, N. Y.

Designing Treadle for Lathe Provides a Neat Problem

IN BUILDING a lathe with treadle action, I decided to design the action to return in 120°, giving a power stroke of 240°. Maybe some of your readers would like to solve that problem with geometry, slide rule, calculus, etc. I did it Edison's way. You remember the story of how Edison set a college boy to find the cubic content of a light bulb. The boy figured a week before he brought in the results. Edison said, "Why not just break off the tip, fill the globe with water, and then pour it into a graduated measuring glass?" On my treadle problem I used rule of thumb and cut-and-try, and it worked, as shown in the sketch. The action could be made to return in 90° with a power stroke of 270°, by setting the fulcrum of the oscillating crank closer to the circumference of the circular crank and shortening the connecting rod and oscillating crank. However, this would not be efficient. Incidentally, people now seem to be astonished to learn that turning can be done by treadle power, but I learned that way in 1898.—J. M. N., Eugene, Ore.



Talk About Perpetual Motion Is What Runs On Forever

TO HELP B. B. develop the perpetual-motion machine he describes in the May issue, I offer a few suggestions for improvements: Why not omit the motor and induction coil and substitute a gas engine for motive power to drive the generator? The plant could be situated at the seashore, and by using the current generated for electrolysis of sea water, hydrogen could be supplied to run the engine. As by-products B. B. would have sodium, chlorine, magnesium, bromine, iodine, and traces of other metals. Part of the current generated could be used to electroplate the wearings parts with some of the recovered metals; this could be regulated by an automatic device (gadget) so that the plating would exactly equal the wear. Once started by feeding the engine a small initial supply of hydrogen, the machine should run as long as the supply of ocean water lasts.—H. L. V., Fullerton, Calif.

All Right, Don't Ask—Here's What to Do With Eggshells

IN VARIOUS issues of your magazine I have read in "Readers Say" of people asking what to do with such things as shirt cardboards, empty cigar boxes, etc. To me these are easy questions. I don't even bother with them. I tackle the real tough ones, like what to do with empty eggshells or orange skins. As for eggshells, I blow out the egg by making a pinhole on either side of the shell and blowing through one of them. Faces can be drawn or painted on the shells. These can be used as puppet heads if you are careful with them. They also make novel place markers for parties.—J. F., Buffalo, N. Y.

Bombers from the bottom of the Deep Blue Sea

THERE'S a fabulous amount of magnesium in every cubic mile of sea water.

Enough magnesium for more than *four million* Flying Fortresses. Enough to lay a continuous ceiling of bombers . . . a hundred miles wide and stretching all the way from London to Berlin!

Now magnesium can't be dredged out of the ocean . . . for every ounce of this rare metal must be produced by electrolysis. This necessitates the conversion of vast amounts of alternating current to direct current, at the very water's edge.

The best means of converting power is the mercury arc rectifier. As long as ten years ago, Westinghouse Research Engineers began experimental work on a *new type* of mercury arc rectifier which would be more efficient . . . more economical . . . less costly to install and maintain than existing types.

These Westinghouse scientists realized that new untapped fields in metallurgy would be opened by the perfection of an improved mercury arc rectifier. In 1937, they brought forth the *Westinghouse Ignitron.*

The Ignitron operates on the radically new principle of *starting* and *stopping* the mercury arc with each cycle. This means that electrodes can be placed much closer together . . . grids and shields reduced . . . arc drop voltage decreased . . . voltage control simplified . . . arc-back practically eliminated. And all of this assures higher efficiency and greater reliability.

More than 1,000,000 kw of Ignitrons are now at work . . . in magnesium, aluminum and chlorine plants, in electric railway systems, in mines, in war industries of many types.

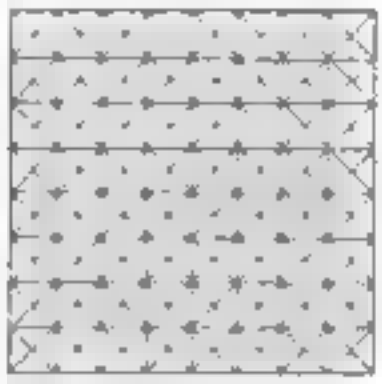
And so, the germ of an idea . . . born ten years ago in the Westinghouse Electronics Laboratories . . . is now contributing its important share in winning the war today.

Westinghouse

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, PITTSBURGH, PENNSYLVANIA

Readers Say:

How Many Triangles Are There In This Drawing?



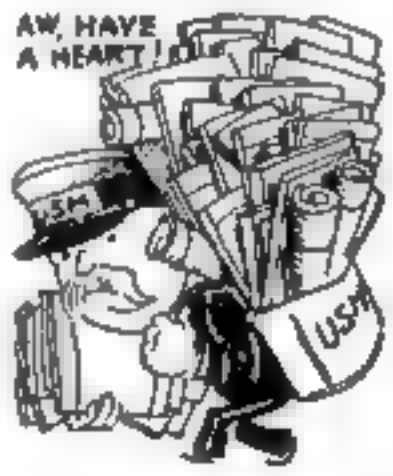
HOW MANY POSSIBLE TRIANGLES?

DURING a few minutes' spare time I was playing with a small ruler and found that I could draw the accompanying diagram. Will one of those master minds in Readers Say please tell me how many possible triangles there are here? I found 500,000 of them. —P. M. C., Dubuque, Iowa.

He Read "Wanted: A Game" —and Invented One

IN THE May issue of POPULAR SCIENCE I read the article "Wanted: A $1,000,000 Game" and was so impressed that I immediately went to work and have originated and made a model of a brand-new war game. I have shown it to several of my friends and they are highly enthused over its possibilities. They say it is absolutely new and immensely interesting. I intend to offer it to several game manufacturers as you recommend. Keep up the good work of your fine magazine—and wish me luck with my game.—M. L. R., Roanoke, Va

And What Does He Read the Rest of the Month?



I AM writing to let you know that I enjoy your magazine very much. I am wondering if you would inquire through Readers Say as to the largest number of magazines any reader gets regularly. I believe I hold some sort of a record in this field, as at one time I regularly got 46 different publications, in the fields of motion pictures, photography, radio, engineering, etc. The number is smaller now, as some of the magazines have combined and others have gone out of business.—E. C., Rudd, Iowa.

If You Can't Use That Can We Know Somebody That Can

SINCE everybody is asking about what to do with what, can anyone tell me what to do with empty cans in which coffee and vegetable shortening have been packed? — B. B., Washington, D. C.

B B. Won't worry about surplus cans much longer.—Ed.

Raymond B. Wailes' Articles Made This Reader a Chemistry Fan

UP UNTIL recently, you have had some very interesting articles on chemistry by Raymond B. Wailes, but they have not appeared lately. The first of his articles I saw in P.S.M., years ago, got me deeply interested in chemistry and I have made myself quite a lab. I wish you would continue Mr. Wailes' articles. —D. A. V., Netcong, N. J

Mr. Raymond B. Wailes died several years ago. The current series of home-chemistry articles in this magazine has been written, for the most part, by Kenneth M. Sweezey.—Ed.

Here's a Box That Holds A Simple Little Problem

HAVING enjoyed working some of the math problems in Readers Say, I would like to submit a simple one. If the outside measurements of a closed box are eight inches, ten inches, and 12 inches, and the total inside surface is 376 square inches, what is the thickness of the material used? -G. T. L., Salisbury, Md.

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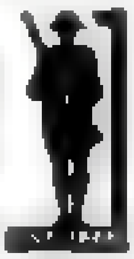

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IN RECENT LABORATORY "SMOKING BOWL" TESTS, *PRINCE ALBERT* BURNED

86 DEGREES COOLER

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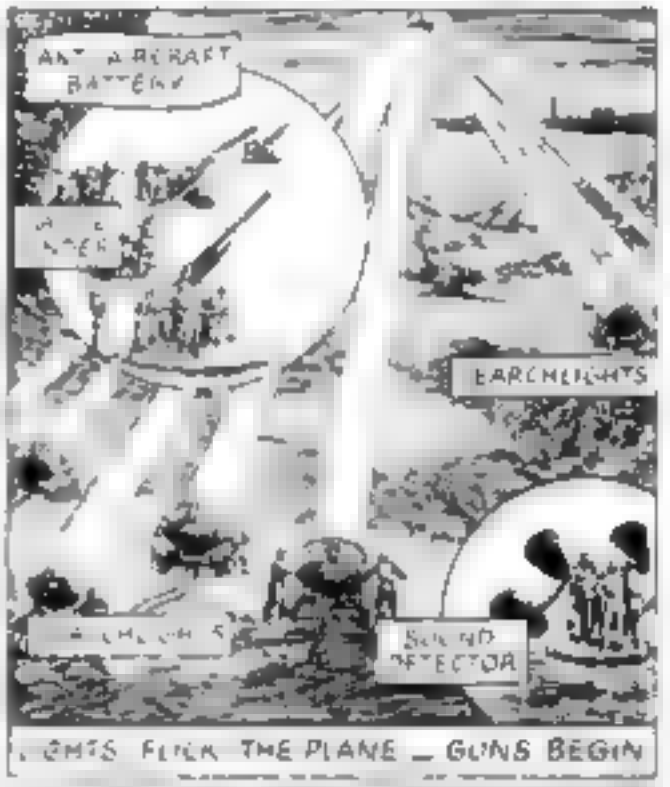
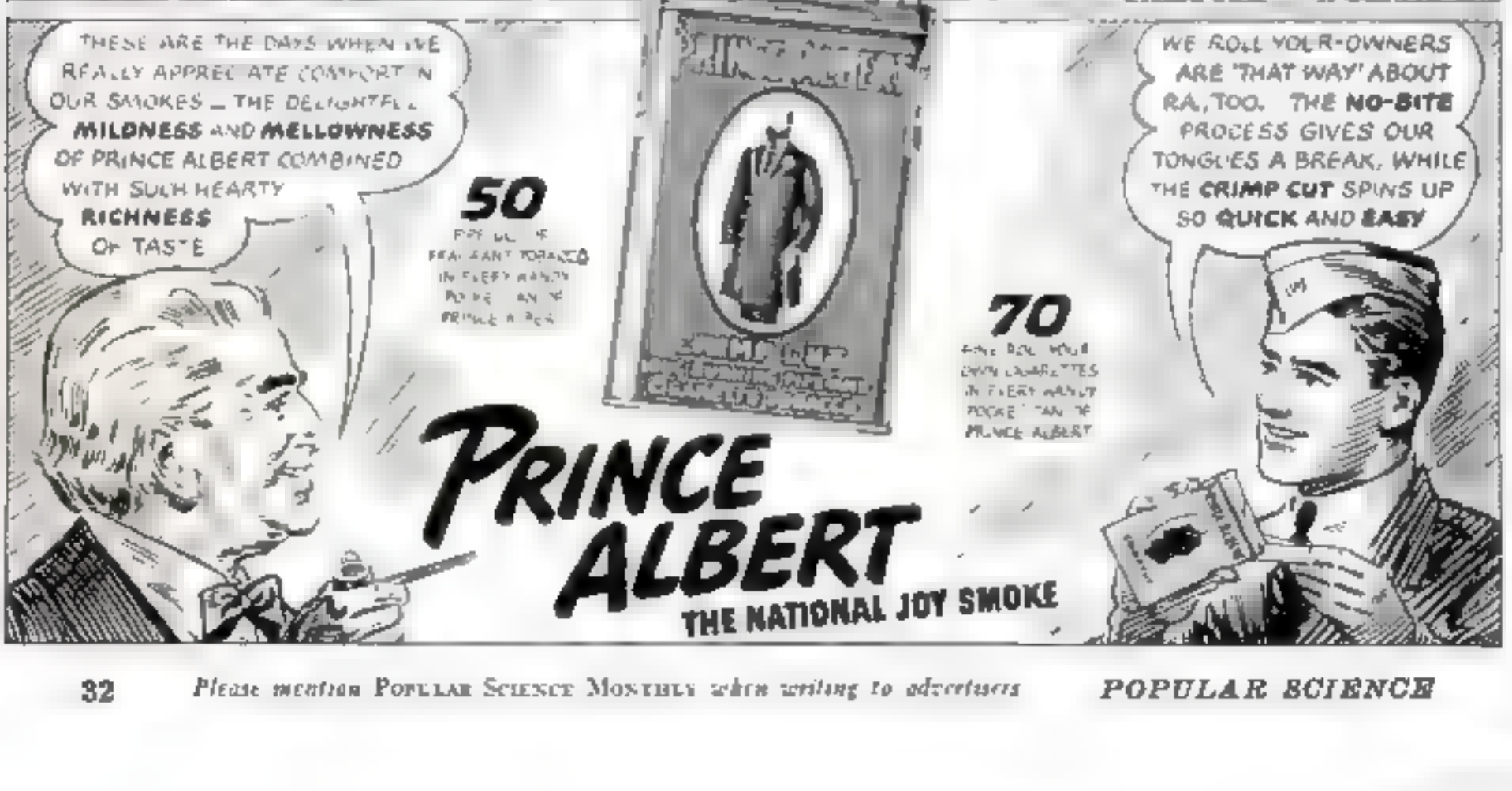
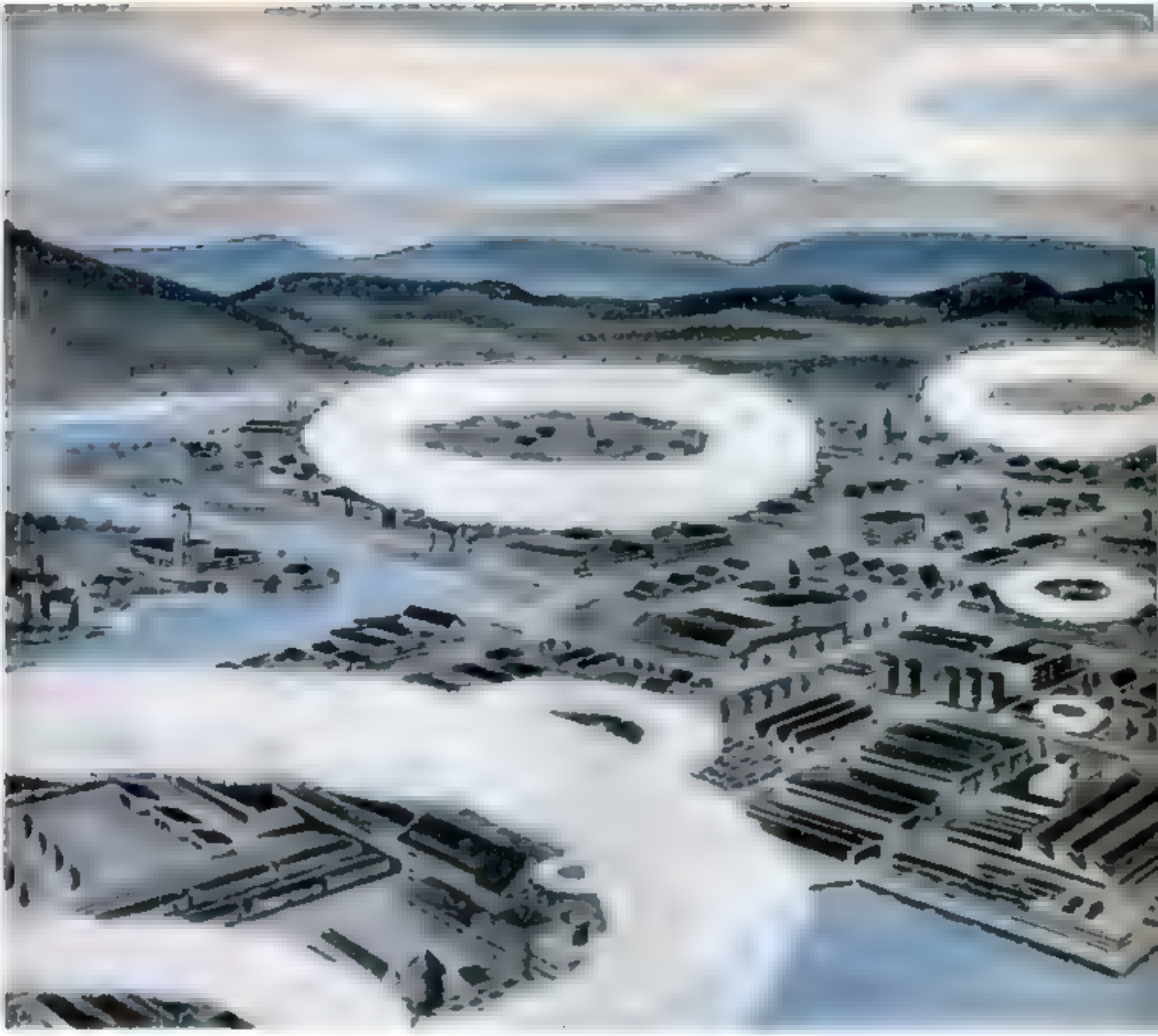






Whirling Smoke Rings to Free Cities of Soot

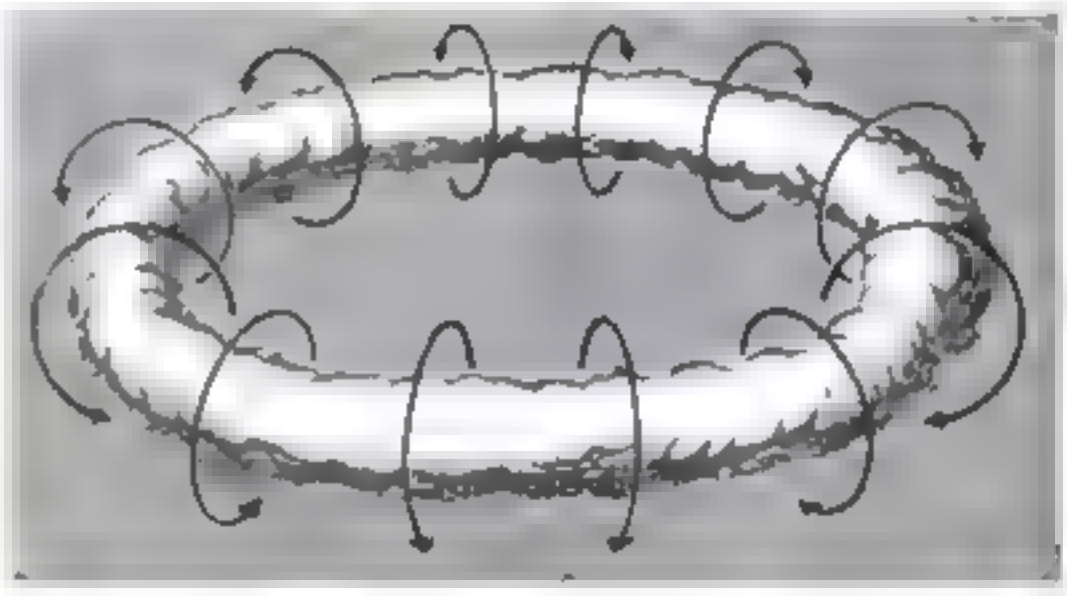
VORTEX GUNS CAN SHOOT FACTORY GASES SKYWARD

DR. PHILLIPS THOMAS, research engineer of the Westinghouse Electric & Manufacturing Company, picked up what appeared to be a small copper and brass drum with an aperture some two inches in diameter in its head. By means of a tubular peep sight affixed to the top of the drum, he aimed the aperture at one of a row of lighted candles about ten feet away, and then tapped the back of the drum with a rubber hammer. Instantly the candle was extinguished. He repeated the performance half a dozen times, and each time the striking of the metal drum was followed by the extinguishing of a candle. He pointed the aperture at a gong, tapped the drum, and the gong rang. In each case, it was as though an unseen projectile had been fired from the strange device.

These seemingly miraculous feats were accomplished by an invisible ring of air, a smoke ring without the smoke, shot from the aperture by the force with which Dr. Thomas struck the back of the drum. Called

Shot from this vortex gun like bullets from a rifle, whirling air rings will extinguish candles at a distance of 15 feet. The hand machine at left will send out vortex rings at a speed of 20 feet a second. They carry so much force that their impact can be felt at about 25 feet

These rings are true vortexes governed by the same principle as that of the familiar rings blown by nearly all smokers. They go in the direction of the initial impulse, keeping smoke trapped as long as they move



a vortex gun and designed on the basis of elaborate mathematical calculations by Westinghouse scientists, this device embodies the first practical application of the well-known principle of vortex motion. Good examples of this motion are the common smoke ring which almost all smokers can blow, and the funnel-shaped twister cloud familiar to anyone who has lived in the tornado and cyclone belts of the Middle West. The twister, however, is only half of a vortex; it moves only if a wind is blowing, and always travels at right angles to the ground. A smoke ring, which is a true vortex ring, will move in any direction, according to the initial impulse, and owing to the vortex motion the smoke will remain in the ring as long as it is moving. The more rapid the motion, the farther the ring will go before breaking up.

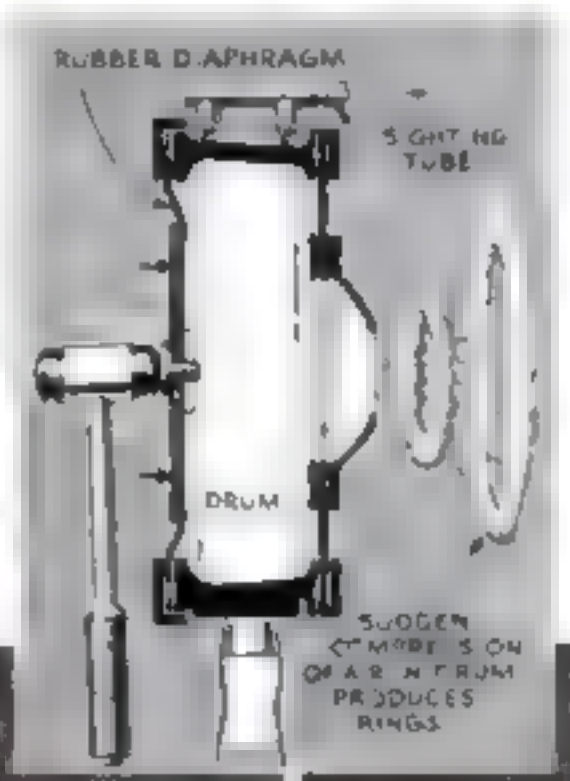
The rings or miniature whirlwinds shot from the vortex gun conform to the behavior pattern of the smoke ring as blown from the mouth. Their size and velocity, and the distance traveled, depend upon the dimensions of the gun and the force with which it is struck. They are always invisible unless smoke or some other visible substance is put into the gun.

Westinghouse engineers have constructed experimental vortex guns in two sizes. The hand model, demonstrated by Dr. Thomas as part of the equipment of a traveling laboratory with which he has been touring the country, is about eight inches in diameter. It shoots a vortex ring, with a diameter of from two to three inches, which travels ap-

proximately 20 feet a second. The impact of the ring can be felt at about 25 feet, and at from ten to 15 feet will extinguish candles and ring gongs. Mechanically operated, this gun will put out lighted candles at the rate of two a second, and could probably be geared to operate several times that fast.

The other model, with which tests are being conducted at the Westinghouse research laboratories in Pittsburgh, is about 6½ feet in diameter, and shoots an 18-inch ring at a speed of 90 miles an hour. It will blow out candles at from 60 to 70 feet, and at 20 feet will knock a man off balance unless he is braced to receive the blow. Guns of from 12 to 14 feet in diameter, constructed of heavy steel, are now being planned. They will be fired with a TNT cartridge, so that a real wallop will be obtained, and will shoot a four or five-foot vortex ring a distance of one mile at the speed of sound, roughly from 800 to 1,000 miles an hour, depending upon atmospheric conditions. A ring of air traveling at this velocity will strike anything in its path with terrific force, and could conceivably knock a heavy airplane out of control. Theoretically, at least, even larger guns, with correspondingly greater range and power, can be built. According to Dr. Thomas there is no practical limit as to size, provided machines can be devised to give sufficient striking force.

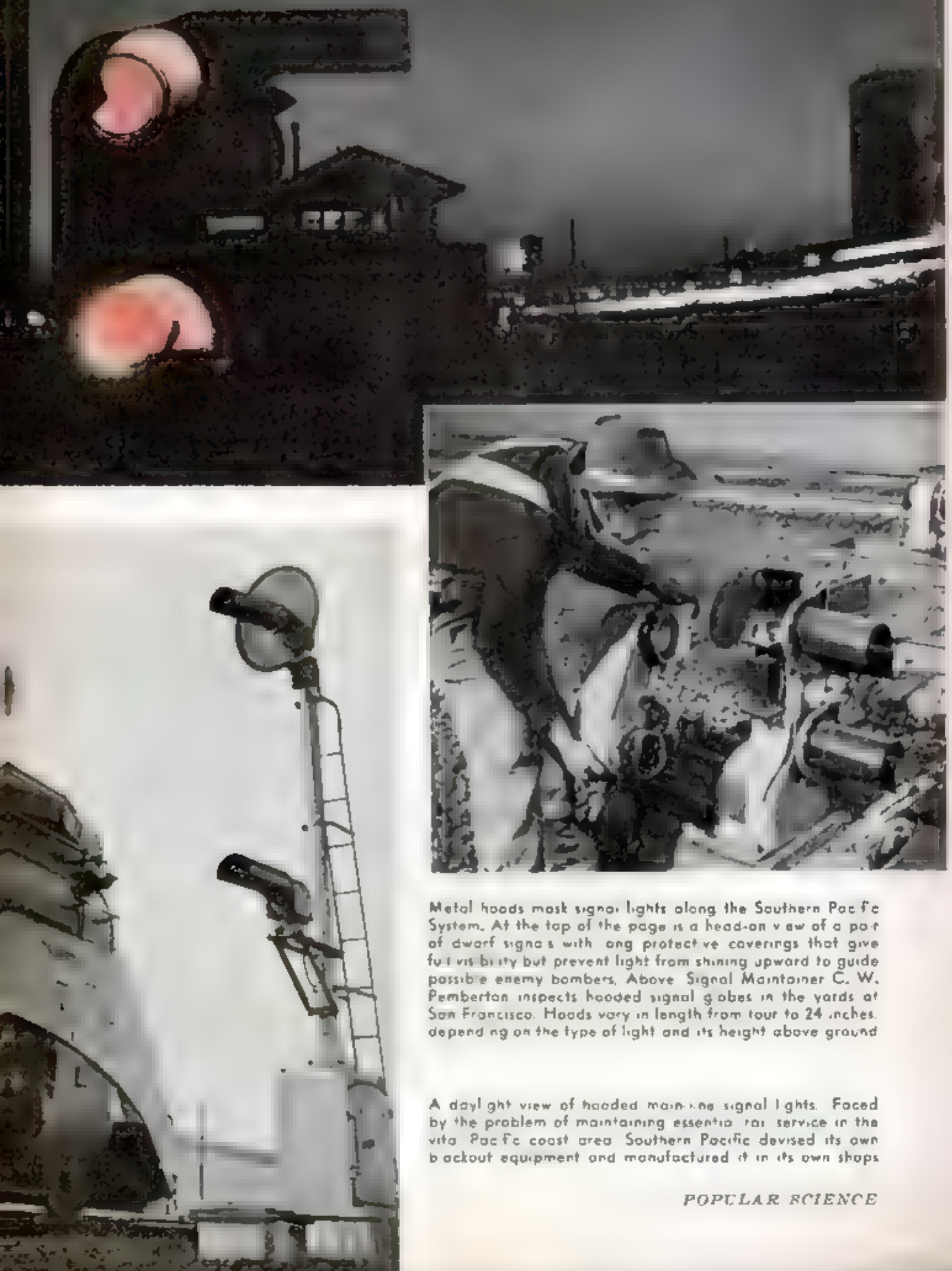
Some of the experiments now under way at Pittsburgh are military secrets, but others deal with the possible use of vortex rings in peacetime. The most promising of these applications so far has to do with the elimination of smoke from industrial areas. Dr. Thomas suggests that it may prove feasible to trap the smoke of a manufacturing plant in huge vortex guns installed just below or above the roof. Powerful automatic hammers would strike the guns at periodic intervals, and the smoke would be sent into the air in the form of vortex rings. Then, instead of low-lying clouds of disagreeable smoke, the air above an industrial plant would be clean and pure, filled with gigantic smoke rings hurtling heavenward at terrific speed. Smokestacks would be unnecessary, and there would also be a war-defense application too, for as Dr. Thomas pointed out, "war planes now find that smokestacks make handy targets."



How the vortex gun works can be seen in the cross section at the left. A larger model, operated mechanically, shoots rings at a speed of 90 miles an hour, and really huge guns are in prospect

Striking the back of the drum with a rubber hammer, as shown by Dr. Phillips Thomas, research engineer, starts this miniature cyclone on its way. Rings are shot through the front opening

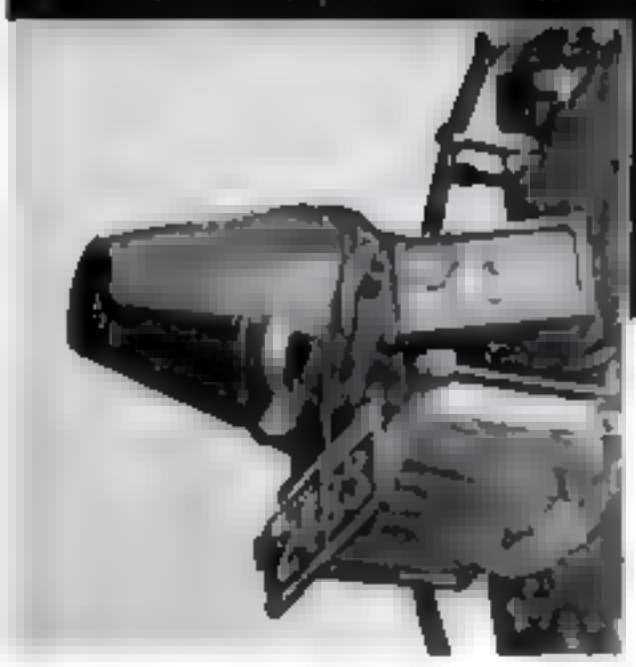
War Blinders for



Metal hoods mask signal lights along the Southern Pacific System. At the top of the page is a head-on view of a pair of dwarf signals with long protective coverings that give full visibility but prevent light from shining upward to guide possible enemy bombers. Above Signal Maintainer C. W. Pemberton inspects hooded signal globes in the yards at San Francisco. Hoods vary in length from four to 24 inches, depending on the type of light and its height above ground

A daylight view of hooded mainline signal lights. Faced by the problem of maintaining essential rail service in the vital Pacific coast area Southern Pacific devised its own blackout equipment and manufactured it in its own shops

THE IRON HORSE



Locomotive with hooded headlight. In the picture above, the light is on full strength; in an actual blackout, a dimmer switch is turned, making the light much less brilliant. At the left is a close-up view of the headlight hood taken by daylight. Light beams are thrown downward, so that no rays can shine up into the sky and serve as a guide for marauding planes in locating military and industrial targets. Storm curtains on the cab are drawn in blackouts, and on passenger trains all lights are turned out except special blue 15-watt lamps

SINCE a lighted train provides a traveling beacon for enemy bombers, the Southern Pacific System has devised pioneer blackout measures for lines paralleling the coast from California to Oregon, and extending inland as far as Nevada. Semicircular hoods now shield giant locomotive headlights, rear-end train marker lights, semaphore lamps, and switch signals from overhead view. Protective screens mask the red glow from the engine's firebox. When blackouts come, the headlight dims, storm curtains of the cab are drawn, and the white plume of smoke turns to an invisible smudge with altered stoking. Lights go out in passenger cars, except for small blue night lamps in vestibules. Window shades of passenger cars remain drawn from sunset to sunrise, throughout the whole blackout area, and windows of mail and express cars have been painted black for the duration.

Even the marker lights at the rear of every train are equipped with hoods over the lenses. Windows of mail and express cars have been painted black for the duration. Shades on passenger windows are kept drawn every night from sundown to sunrise as a safety precaution, even if there is no alarm

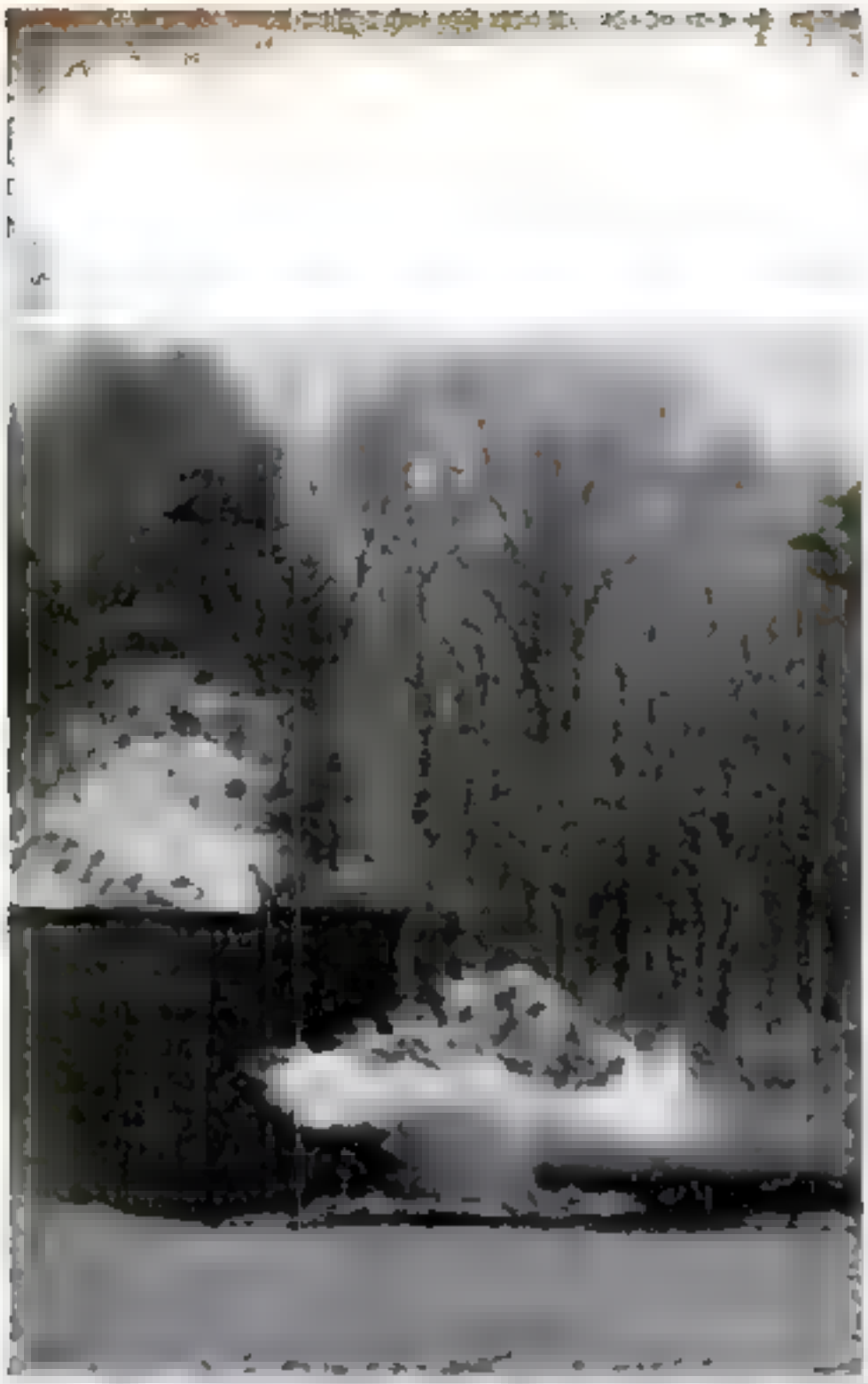
AUGUST, 1942

Assault Troops Silence

THE FLAME THROWER HAS PROVED ITSELF A POWEFUL WEAPON FOR CLEARING OUT EMPLACEMENTS THAT GUNS CAN'T CRACK

• • •

This s a portab e flame pro ector L ke other weapons of its kind it s composed of a reservo r for o a cyl nder of compressed prope lant gas and a nozzle w th an ign ting dev ce



Pillboxes with Fire

By COL. ALDEN S. WAITT

The writer of this article is attached to the Chemical Warfare Service. His book, "Gas Warfare," is scheduled for publication in midsummer.—Editor's note.

THE flame thrower or liquid-fire gun is the most spectacular of all the weapons of war. German *flammenwerfer* units have been credited with great accomplishments during the drive through the Low Countries and France in 1940. Judging by the numerous reports of its use, both the Germans and Japanese consider it has a very definite place in a carefully organized attack on a fortified position, and is a useful weapon for clearing dugouts, trenches, and emplacements.

The range of a flame thrower depends upon the distance that the burning oil can be thrown before it is broken into a fine spray or consumed by burning. Because of the short range of the portable device, it is essential for the man operating it to get very close to his target to make the flame effective. A German attack on a concrete emplacement or pillbox begins with heavy bombing or artillery fire. Close behind this bombardment the engineers and infantry approach with wire cutters, grenades, and heavy explosives supported by smoke and strong machine-gun and rifle fire. When a breach is made in the barriers surrounding the pillbox, the flame-thrower detachment rushes close in and directs flame against the openings and sides of the emplacement. Where the flame strikes, there is a blazing mass that flows through every crack and loophole and burns fiercely on the other side.

Flame throwers were not used by American troops in the First World War. While they were several times attacked by *flammenwerfer* units, our riflemen and machine gunners made it difficult for the Germans to get close enough to do any harm. The only work done on the flame thrower at that time by the Chemical Warfare Service was the carrying on of investigations relating to the possibility of its development.

The German flame throwers of the First World War were of two types, which are similar to those

In the fuel pack are two tanks that hold oil, and a tube containing compressed gas which propels the inflammable liquid through hose and nozzle

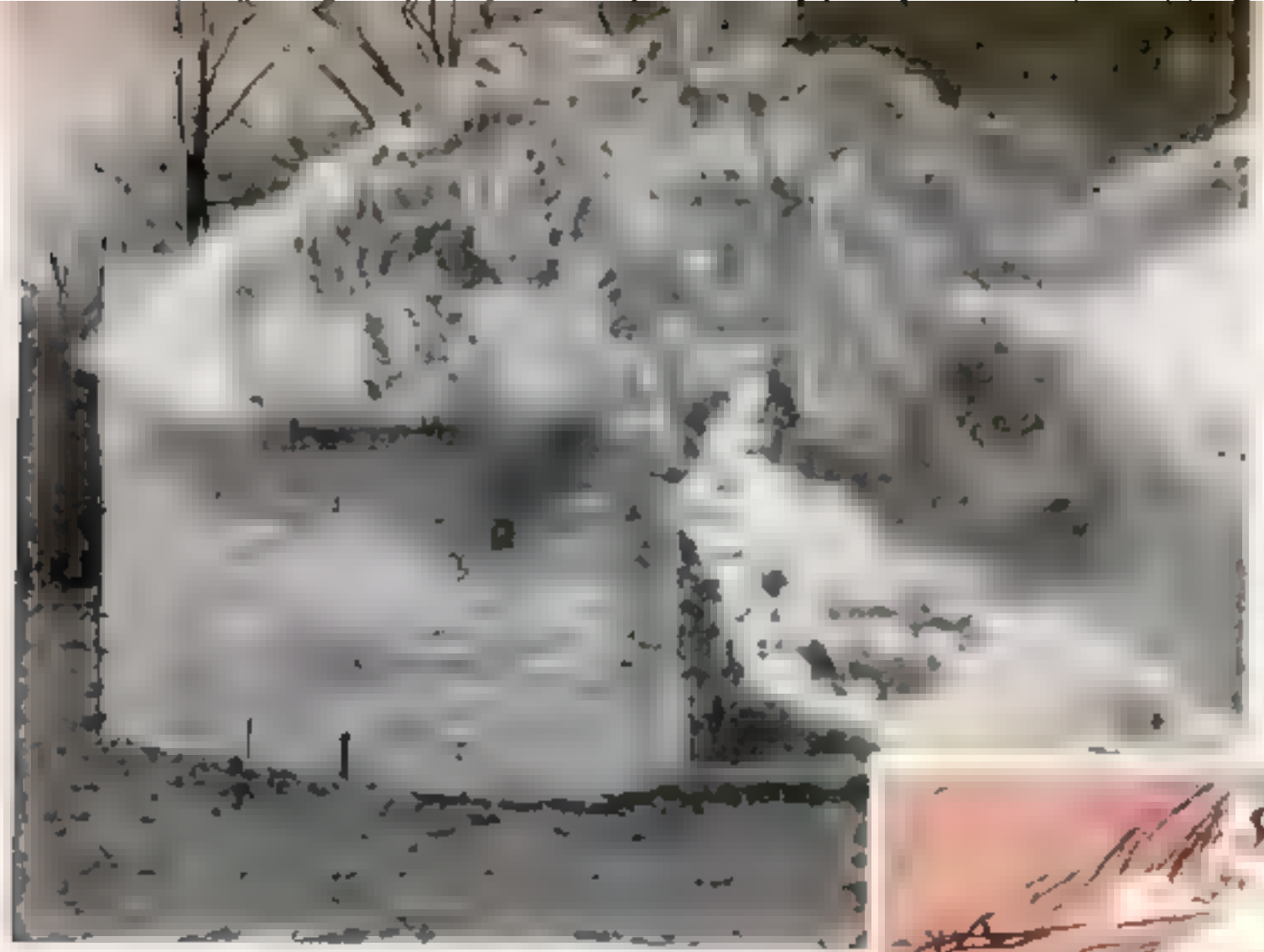
1 GETTING THE RANGE. In attacking a pillbox or emplacement, the operator fires short bursts of flame, feeling for the target and correcting his aim as though he were playing a water hose. Flame throwers are not sighted like rifles or guns

2 ON THE TARGET at last, the soldier fires longer bursts, covering the sides of the emplacement and seeking out openings. The flame from such weapons is effective for a distance of about 25 yards. Greater ranges are possible with heavier equipment but portability is sacrificed

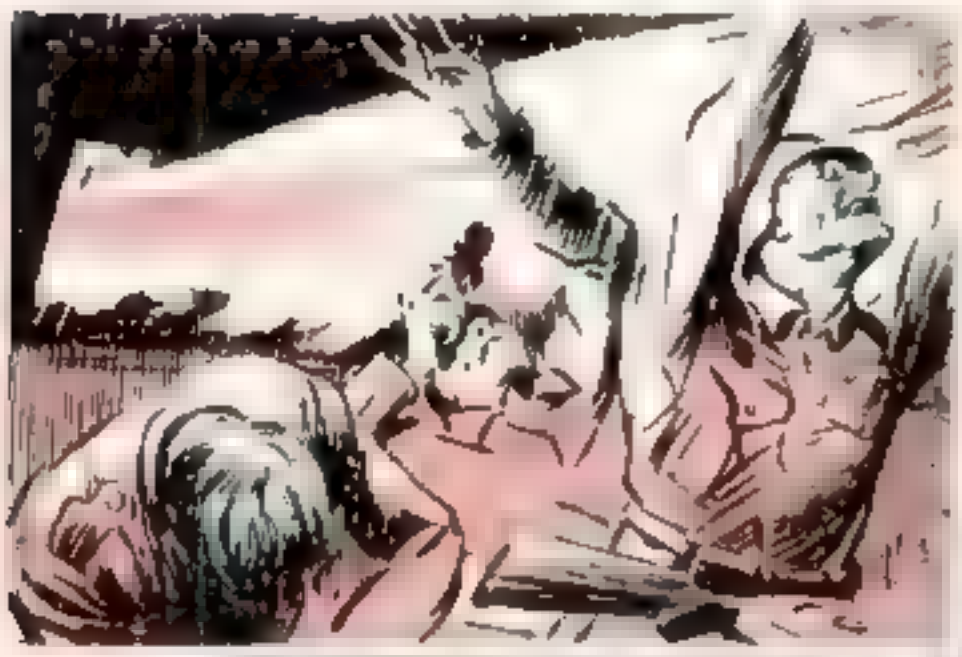
now employed: a large one to be buried on the parapet of a trench, with a supposed range of 60 to 70 yards, and a smaller type to be carried on a man's back, with a range of about 25 yards. Both types consisted of a receptacle divided into two tanks, the upper filled with nitrogen under a pressure of 1,200 to 1,400 pounds per square inch, the lower filled with inflammable oil. To the receptacle was fitted a long, flexible tube with a nozzle containing an automatic friction lighting device. When valves were opened, the oil was subjected to pressure of the nitrogen and forced through the tube.

In the American experiments during the first World War, the Lawrence projector made by the British was used, and American flame throwers grew out of this apparatus. The Lawrence consisted of an oil reservoir holding three gallons of inflammable fluid, a container of propellant gas under a pressure of 1,000 pounds per square inch located inside the oil reservoir, a nozzle for directing the stream, and an ignition system for igniting the oil as it left the nozzle. This system consisted of six small cartridges carried in a case similar to that of an automatic pistol. For firing, they were pushed into place by means of a rod along the discharge pipe and were ignited by an electric current from a small battery. One lever operated by the left hand controlled the opening of the propellant-gas container and fired the cartridge.

All flame throwers follow about the same pattern: a reservoir of oil, a source of pressure to expel the oil through a pipe, and a device to ignite the fuel. The principal difference lies in the ignition devices. Ignition may be with an electric spark lighting a stream of easily combustible gas, a cartridge to ignite the gas, or a friction lighter which ignites a fast-burning mixture of combustibles, all of which in turn supply the necessary heat to ignite the flame-producing liquid.



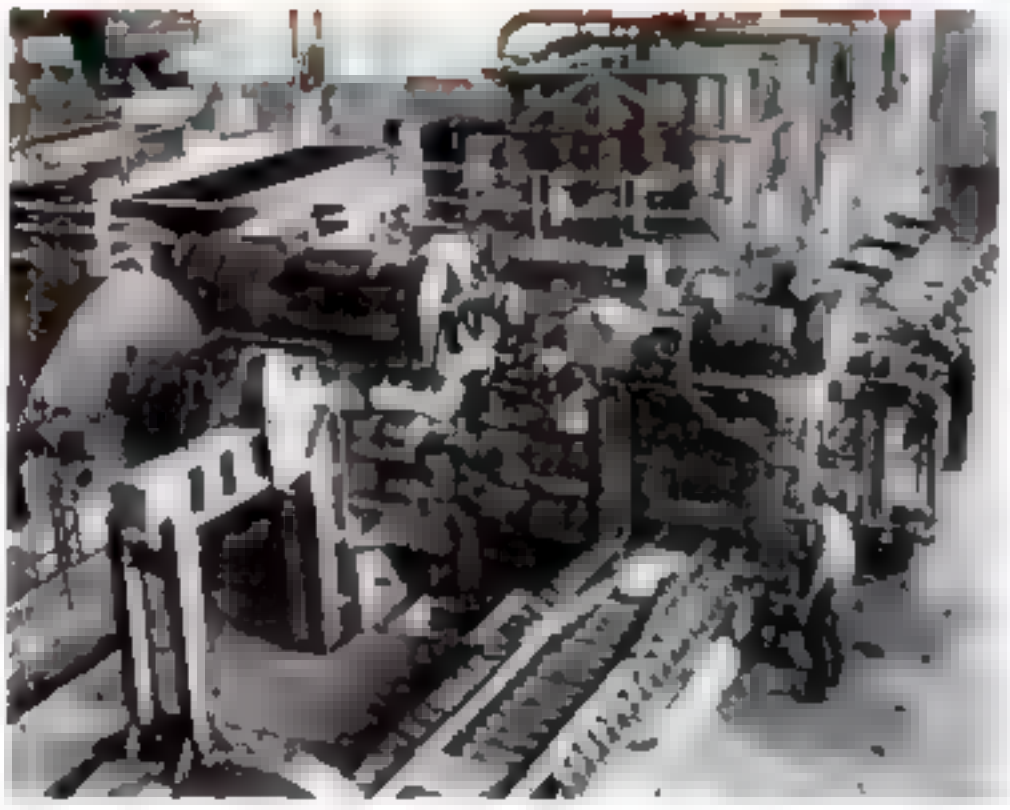
3 ENVELOPED with flame the pillbox is a very uncomfortable spot for the defenders in the German sweep through the Low Countries in 940 the flame thrower proved to be a time saver in clearing dugouts, emplacements and other confined spaces that could not be reduced quickly in other ways



4 INSIDE THE PILLBOX, flames pour in at even the smallest opening This photograph made in connection with the test shown on these pages shows what happens at a two by two-inch port A hit of this would make a position untenable

Brass and Heat Make Cartridge Cases

Evolution of a cartridge case for a 20-mm. automatic



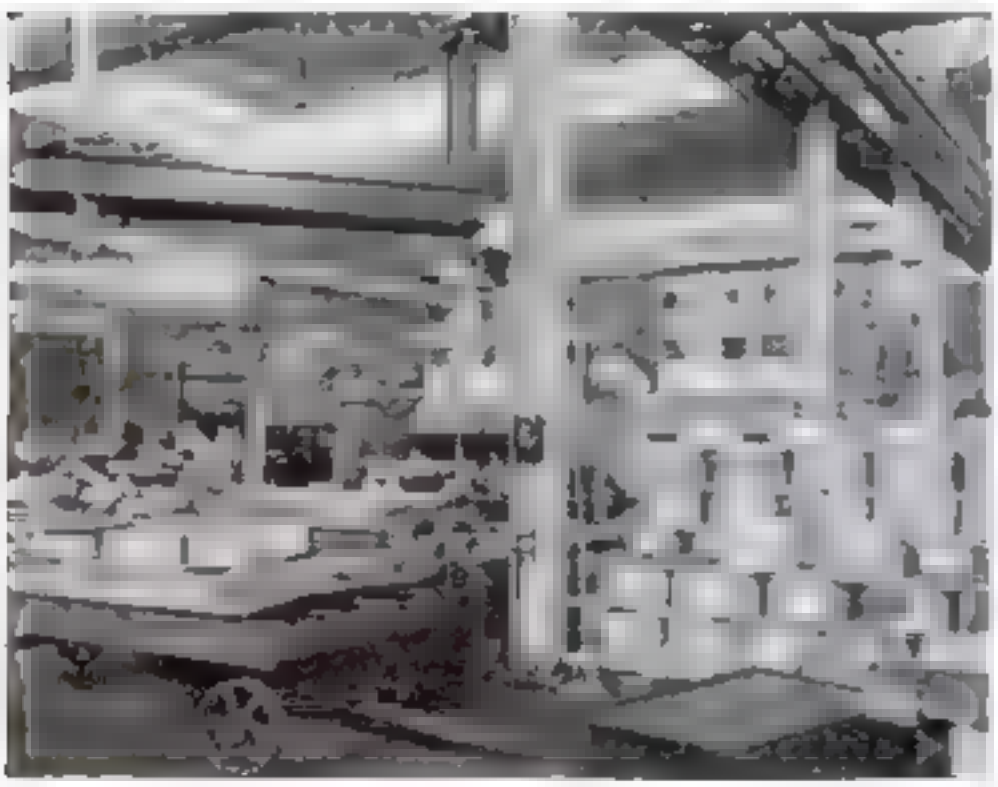
In this breakdown mill and continuous furnace, brass cakes, the raw material of shell cases, are heated and rolled into long, flat bars. Temperature and heating time are controlled automatically to insure proper qualities in the metal

BRASS plus heat—that is the recipe for the cartridge and shell cases that translate American fighting spirit into language that the Axis powers can understand.

In a typical Eastern plant converted to all-out war production, electric furnaces produce millions of pounds of the ammunition alloy each month, by melting together 69 percent of copper and 31 percent of zinc. Preparing the metal requires more processing than the actual manufacture of the cases, but both require special heat treatment at almost every operation

Brass castings weighing hundreds of pounds apiece get their first flattening in breakdown mills, and further rolling in an intermediate or run-down mill, finally being formed into cylindrical coils of the sheet

Further rolling in intermediate or run-down mills leaves the brass in the form of coiled sheet metal, here being loaded onto trays for running through annealing furnaces



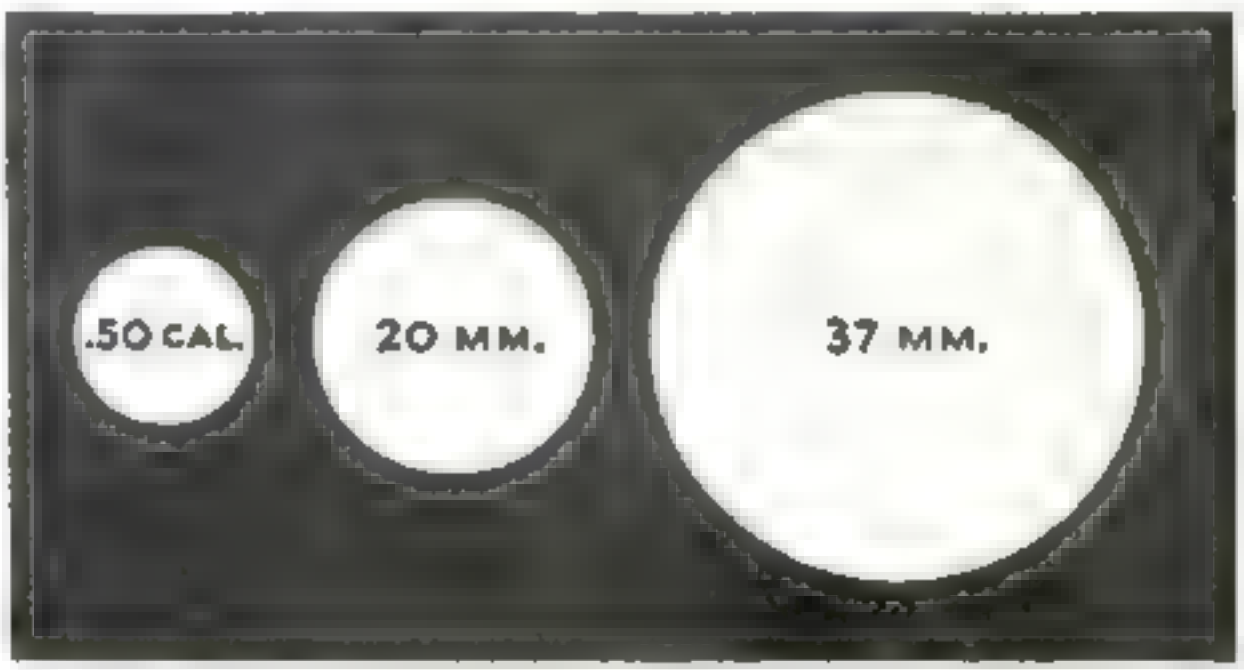
Hydraulic pushers, electrically operated by a time clock, shove brass billets through the oil-fired extrusion furnace shown below

SHEET-METAL METHOD OF MAKING 20-mm. SHELL CASES

cannon. Powerful hydraulic presses punch a disk of brass into a sleek cylinder for the propelling charge

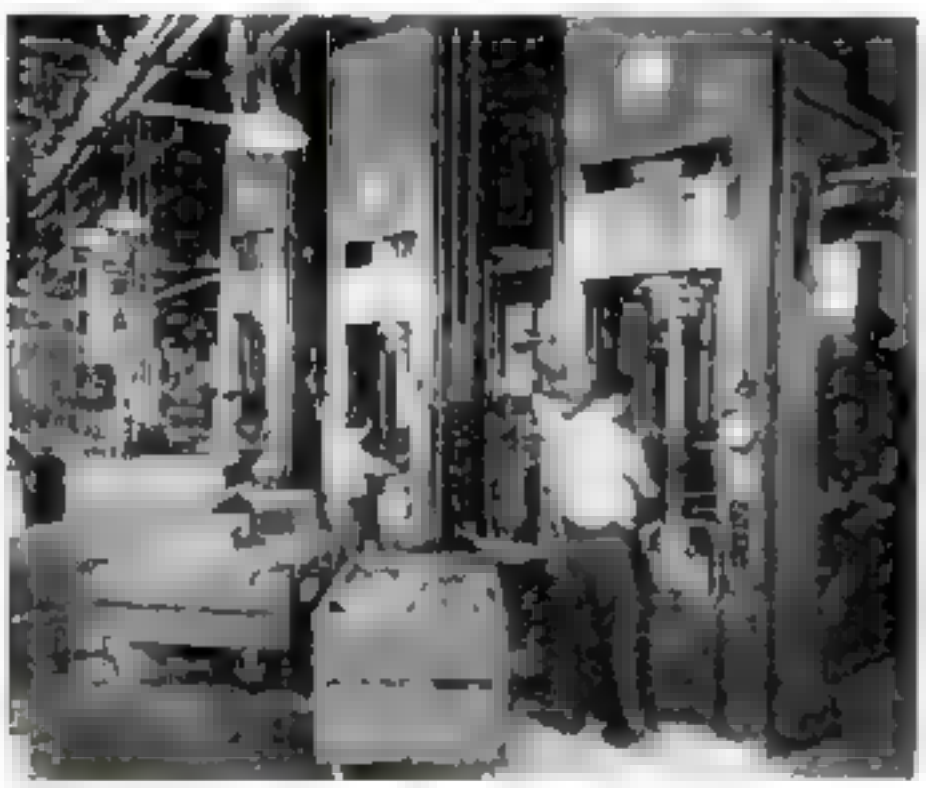
metal ready for cutting.

Now, powerful hydraulic presses go to work on trimmed "blanks" or disks cut from the metal. A punch forces the brass into the cavity of a die, first forming a shallow thimble. In successive operations, the step is repeated, forming a deeper cylinder each time. Finally, finishing operations form the shoulder and neck; the case is headed and indented; and identification numerals and letters are stamped on. At the top of these pages, the stages in forming 20-mm. cartridge cases are shown. Automatic cannon or super-machine guns using this type of ammunition are employed principally on fighter aircraft. Others of the fifteen different sizes of cases made at the plant range up to five-inch size. For cases of all sizes, the manufacturing process is basically the same.

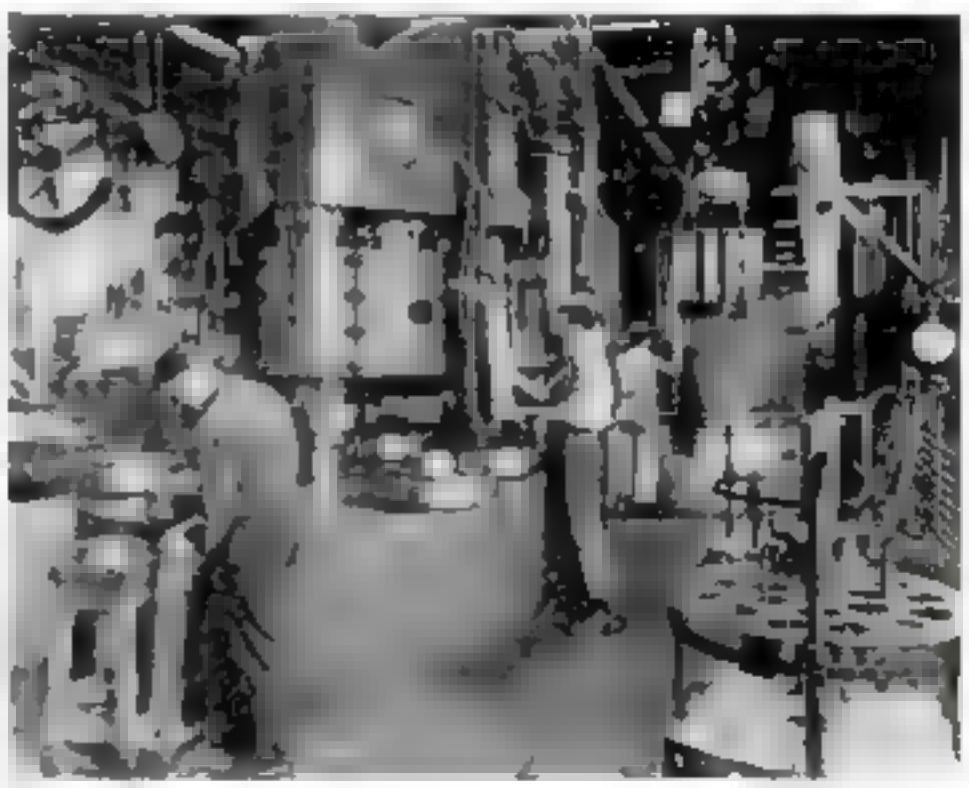


A 20-mm. shell has about the diameter of a nickel; a 37-mm., of a dollar

In these hydraulic presses, large-size brass cartridge cases are drawn from the sheet metal. Successive punchings produce the desired shape



Cartridge cases in the making: Men and machines keep busy to fill the hungry belts and clips and magazines of weapons being used on land, at sea, and in the air



GERM SYRUP FOR VITAMINS

NEW MEDICINE MAY MAKE PLAIN STRAW A HEALTHFUL DIET

WITH the aid of a natural bacterial syrup, it may be possible for man to get the full complex of B vitamins from a straw diet. This discovery is the result of numerous experiments with laboratory animals which, after being given small doses of the "germ syrup," were able to digest cellulose materials and manufacture B vitamins in their digestive systems. According to Dr. Gustav Martin of the Warner Institute for Therapeutic Research, New York City, the "germ syrup" is similar to the substance which enables cows to manufacture B vitamins through the digestion of grass. By taking it regularly for a period of about a month, humans may be able to produce vitamins in much the same manner.

Dr Martin and his associates began their experiments on the theory that the factor which produced B vitamins from food particles in the alimentary canal might be the natural layer of bacteria with which the intestines in all animals are covered from birth.

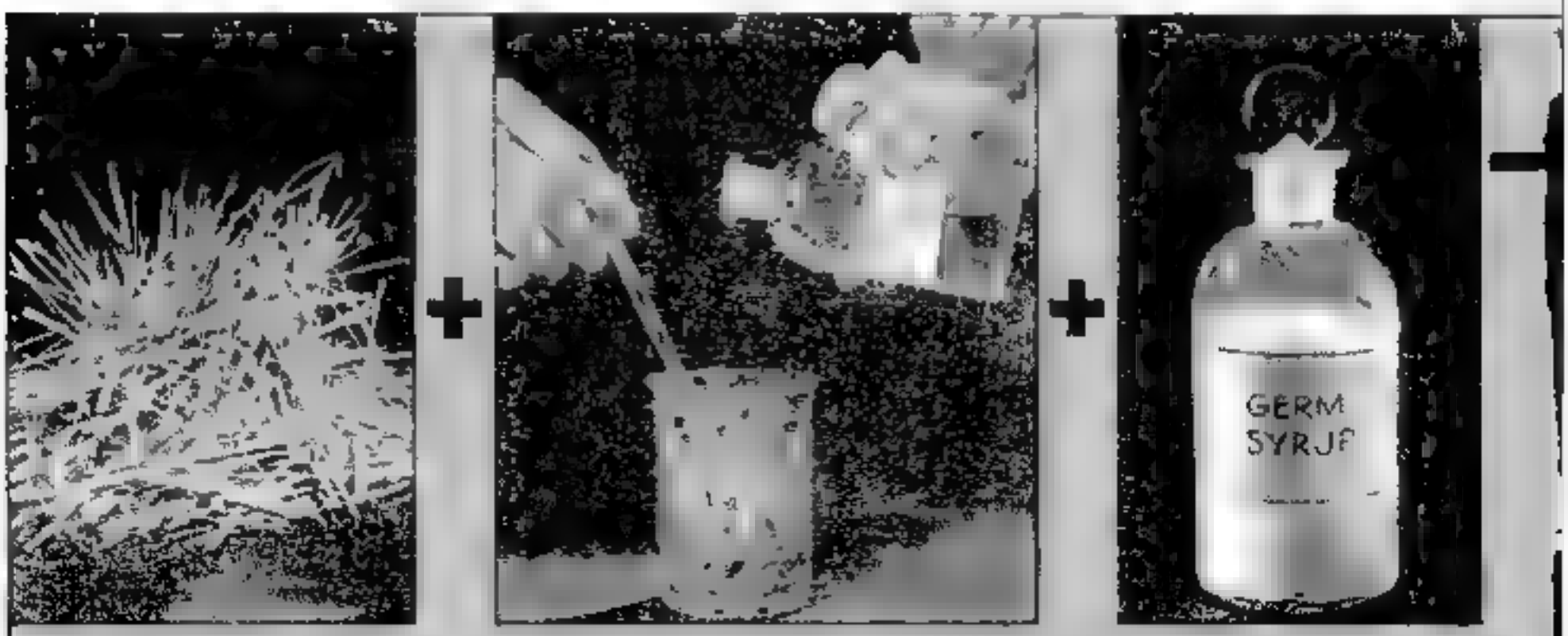
Dr. Martin discovered that these bacteria, which are of two types, underwent drastic changes between youth and old age. The type known as aciduric bacteria was much more abundant in infancy, while the other, called the proteolytic, became dominant in old age. To learn the part played by these germs in the production of vitamins, Dr. Martin fed two healthy young rats on a well-rounded, vitamin-enriched diet. One rat, however, was also given a medicine, aseptoform, which would kill the bacteria in the large intestine. If Dr. Martin's theory was correct, loss of the bacteria would result in symptoms of vitamin deficiency

After several days it was noted that the rat which had been getting the medicine was decidedly the worse for wear His fur was losing its color, his tail was partially paralyzed, and he was losing the sight of one eye, all of which were definite indications that he was not manufacturing the proper amount of B vitamins.

By giving the sick rat some such substance as lactose or dextrose, which doesn't digest readily in the intestinal tract, Dr.

HOW CELLULOSE FOOD IS TRANSFORMED BY NATURE AND THE

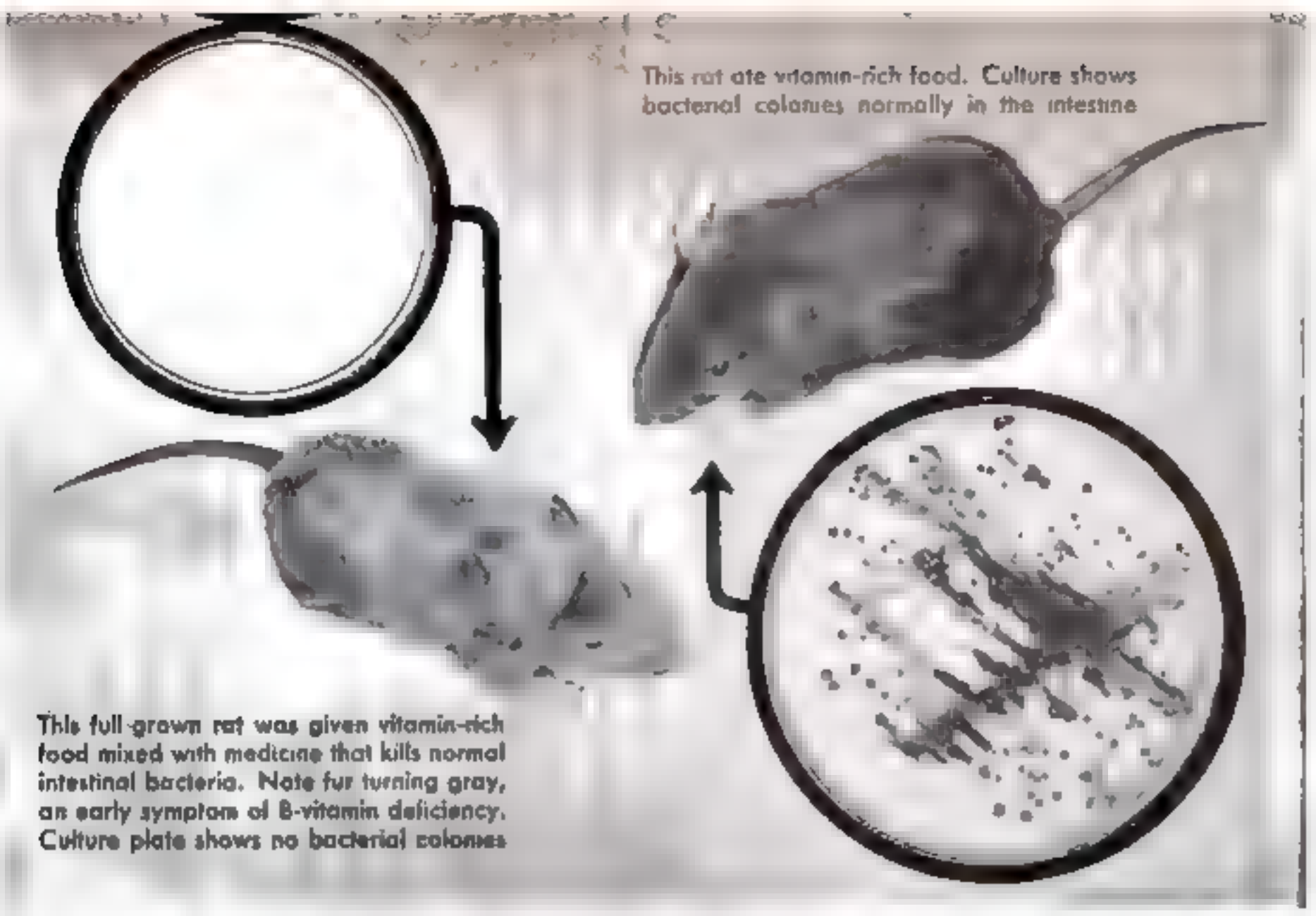
Steps by which B vitamins are created in a rat's intestines when fed germ syrup and straw. It is similar to the way naturally occurring germs create B vitamins from normal food. The syrup is like that with which a cow makes B vitamins from grass, therefore may well enable man to make them from straw



A cellulose material such as straw could be eaten without any special preparation

Upon entering the stomach, the straw would mix with digestive juices, which would break it down into very small particles

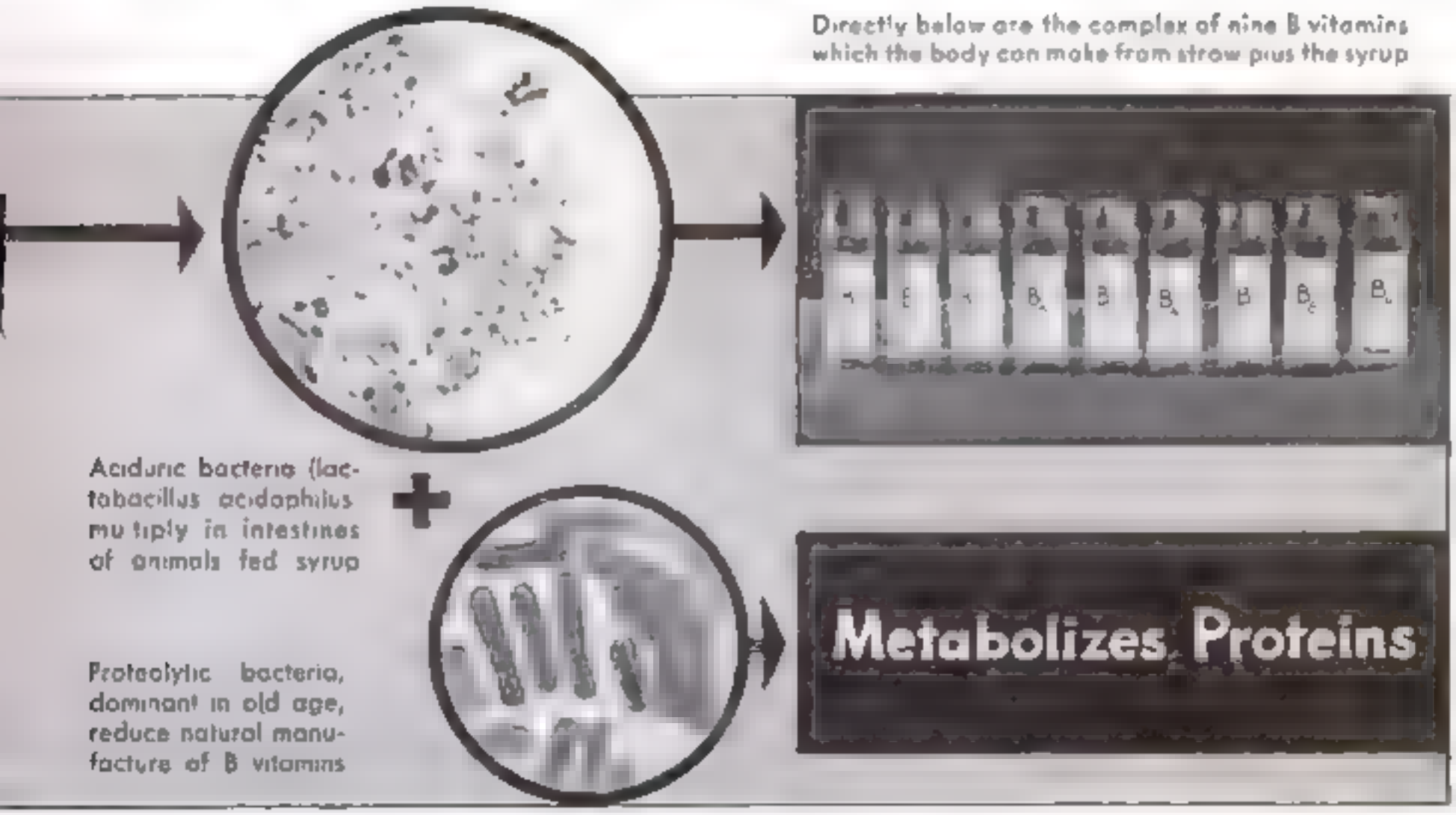
... and these are digested by the body with the help of the special germ syrup



Martin was able to administer at the same time a culture of the missing bacteria, which at once multiplied within the intestinal tract. An improvement in the condition of the rat was evident immediately. So far all similar experiments with the germ syrup have turned out successfully.

It is unlikely that man will ever be forced to subsist on a cellulose diet, but the new germ syrup may eventually prove invaluable to paratroops and others who happen to be away from normal food sources.

NOVEL GERM SYRUP INTO VITAMIN-B-PRODUCING BACTERIA



As part of his course in "preventive maintenance," Brigadier General M. S. Eddy tries his hand at driving a six-ton truck

The General

TO "KEEP 'EM ROLLING," BOTH OFFICERS AND MEN ARE LEARNING A BRAND-NEW MILITARY GOSPEL —"PREVENTIVE MAINTENANCE"

THE Army is motor minded. At all its principal motor schools it is preaching a new military gospel. It is called "Preventive Maintenance," and its tenets embody an entirely new attitude toward the motor transport which plays such a vital part in modern warfare.

At the Holabird Quartermaster Motor Base near Baltimore the visitor, if he is fortunate enough to get in, is apt to see a sergeant or perhaps a lieutenant showing a dignified two-star general the latest wrinkle in testing a truck's efficiency. And on the roads near the base the civilian motorist, pulling over to let an Army convoy pass, frequently finds to his surprise that the trucks, from quarter-tonners to six-tonners, are being driven by generals, colonels, and majors. These high-ranking chauffeurs are pupils, taking the Army's "Preventive Maintenance Course for General and Field Officers." They are acquiring technical knowledge which in the old days was considered unnecessary for military higher-ups. More important, they are being indoctrinated in right methods of using and caring for motor transport, with emphasis on how to prevent trouble rather than on how to make repairs. From Holabird they will go into the field to spread the doctrine and impose the new standards throughout the Army.

Preventive Maintenance stems from the realization that the internal-combustion engine has revolutionized ground warfare (in addition to making possible war in the air). The weapons and men in this war are transported by trucks; tanks and planes are serviced by them. A modern army commander must realize that the wheeled vehicle is a fundamental weapon of war in its own right.

Or, to state the matter in its simplest terms, the Army had to teach itself that a good truck, just as truly as a good cavalry horse, will give better service if it is gentled along and pampered a bit with care and attention.

Now, Americans always have taken it for granted that this country made the most and best automobiles, and grew the most and best drivers. But it may be that the national

A common scene at Holabird Quartermaster Motor Base. Three colonels listen while a captain explains the marks on an oil gage

Drives a Truck

pastime of driving carefully-built passenger cars over carefully built superhighways made us a shade too complacent over the "foolproof" reliability of our machines. An Army truck, hauling the loads it has to haul, getting over the terrain it must get over, can't be made that way. Designer and builder can give it a lot, but the foolproofing has to be built, not into the driver's seat, but into the seat of the driver's pants.

That's where Preventive Maintenance comes in. The basic idea is to get the best equipment and the best men to handle it, and train them to get the best out of it. As a formal program at Holabird, however, they break the plan down into five phases:

1. The selection, by physical and psychological tests, of men best fitted for the tasks of heavy driving.

2. Thorough driver training, with safety, efficiency, and economy of operation as the major goals.

3. A carefully worked out program of daily care, inspection, and servicing of equipment.

4. Systematic organization of technical repair services from the front-line zone back to the base.

5. Creation of a widespread engineering and testing setup to work with the factories in designing and producing needed equipment, and to press for the twin goals of *simplification* and *standardization* of that equipment.

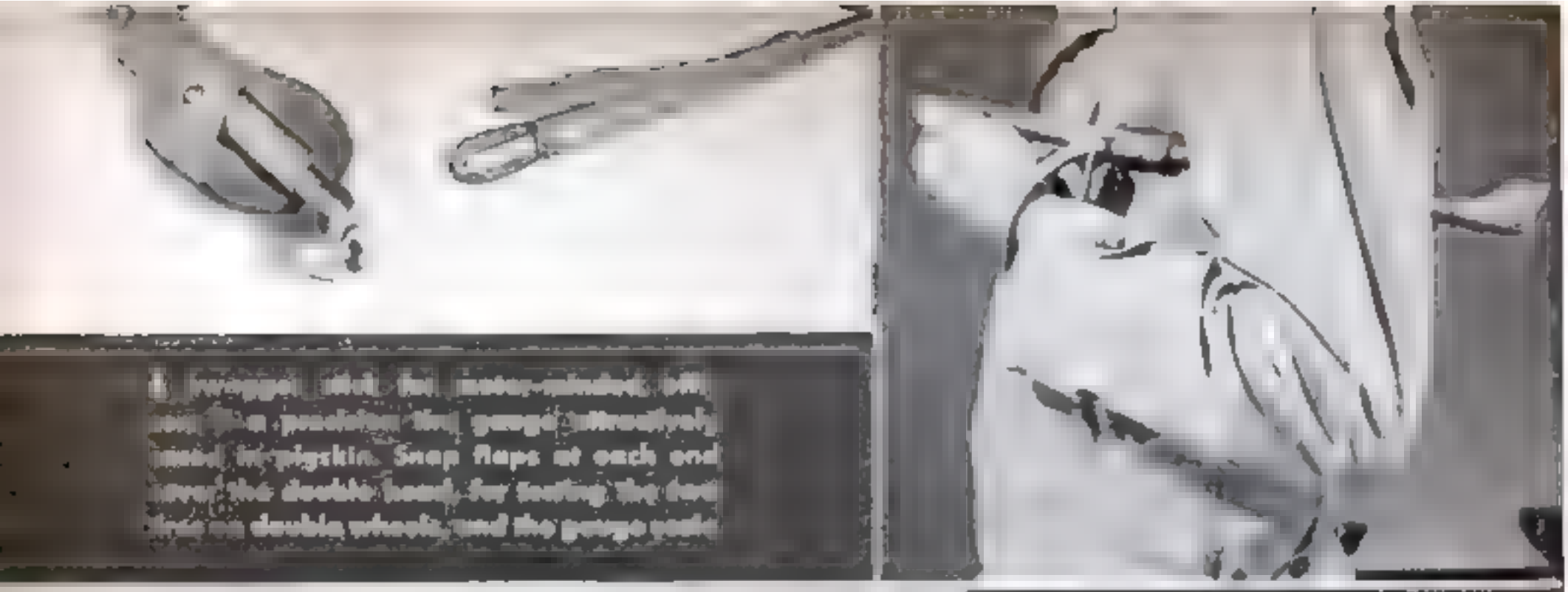
This kind of motor-minded planning got a tremendous boost last year when the Army held its greatest peacetime maneuvers, and a lot of officers and men learned—the hard way—that a truck that won't run is no more a military asset than a gun that won't shoot. Worse than that, it may keep out of action a gun that would shoot if it had the chance.

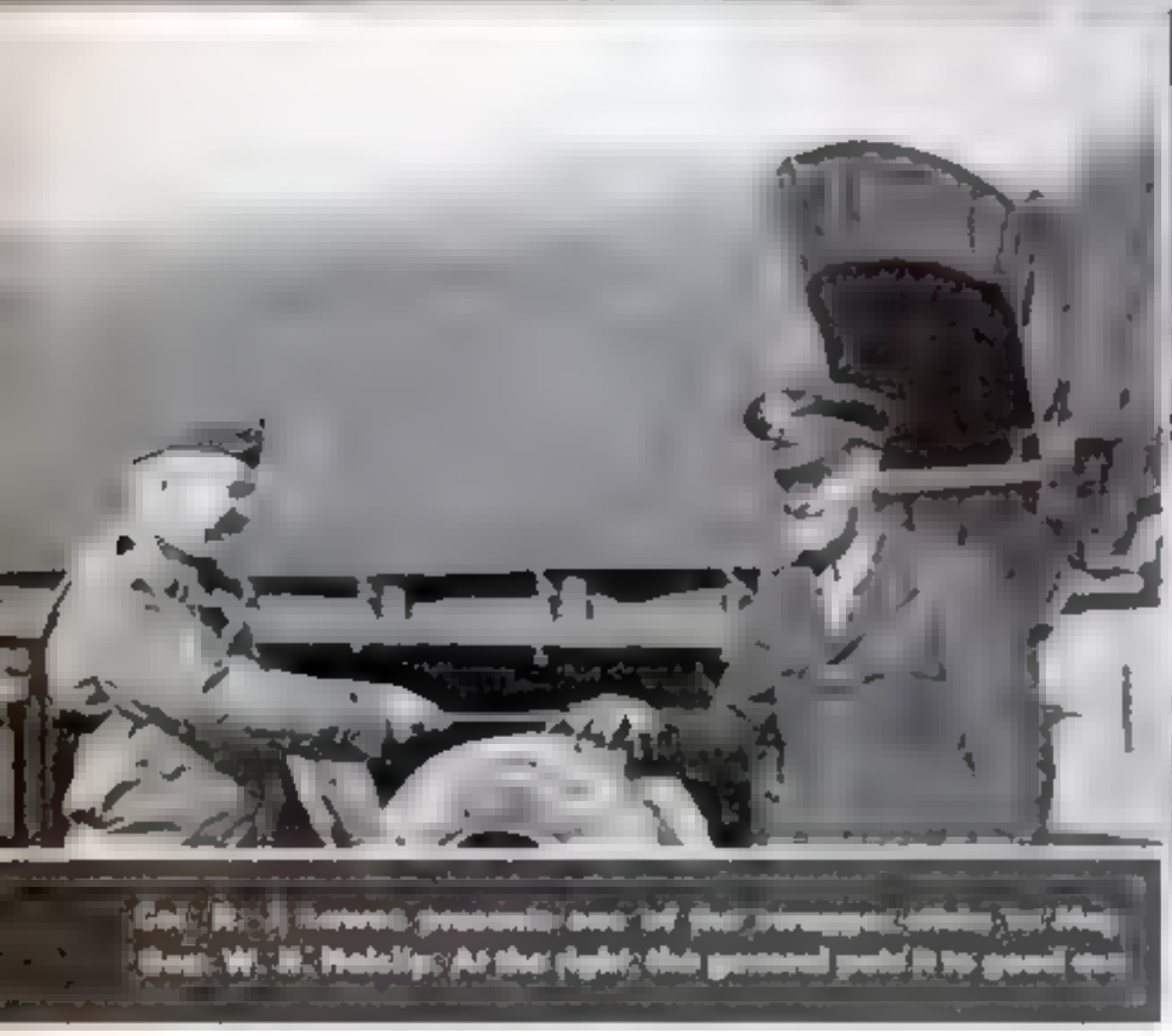
The rock-bottom fact about war today is that the vehicles, whatever they may be, have got to get through. The course of battle moves with relentless speed, and a case of motor failure can be every bit as valuable to the enemy as a direct bomb hit.

Col. H. J. Lawes, Commandant of the Q.M. Motor Transport School at Holabird, summed it up this way:

"You aren't likely to hear any general crying 'My kingdom for a horse!' in this war—but you might hear one muttering. 'A fuel-pump bowl! My stars for an eight-cent fuel-pump bowl!' "

Some such vital gadget is the modern equivalent of the famous horseshoe nail, for want of which the shoe, horse, rider, message, and battle were lost. And that item is an excellent example of how the Holabird program works. The fuel-pump bowl is built to trap sediment in the gasoline supply;





the old type was of glass, perfectly serviceable, but capable of being broken by a freak hit from a bouncing pebble. Now a metal bowl is replacing it. The new type is unbreakable, and of course it's opaque, too, so it must be opened up, inspected, and cleaned at regular intervals. That is the essence of Preventive Maintenance—get a safer, sturdier part; standardize it; set up a fixed procedure for taking care of it.

The "fiddlestick" is another Holabird innovation. It's really a swagger stick for motor-minded officers, a handsome article of haberdashery—long, slender, cased in pigskin and very similar to any other swank riding crop or officer's swagger stick. On close inspection, however, it turns out to be a precision tire gauge with a double head and long barrel so it can be used to measure the pressure of the inner tire on heavy, double-wheeled trucks.

The gauge serves a double purpose. It is a constant reminder to the officer himself of the importance of such a basic thing as tire-pressure inspection, and it is mightily impressive to the men under his command as a lesson in high standards of vehicle maintenance.

More complex Holabird mechanical developments include a special oil-bath air cleaner, which has greatly improved motor performance under bad dust and sand conditions; a portable high-speed battery charger; a portable compressed-air unit; and beautifully compact ignition, battery, and circuit testers.

Of all the vital and vulnerable spots on a modern car, perhaps the battery is the most important. And military service is particularly tough, with its repeated stops and starts, and its relatively short road runs which give the generator little chance to re-

Modern war is waged with trucks like this big six-tonner, and "preventive maintenance" keeps them rolling.

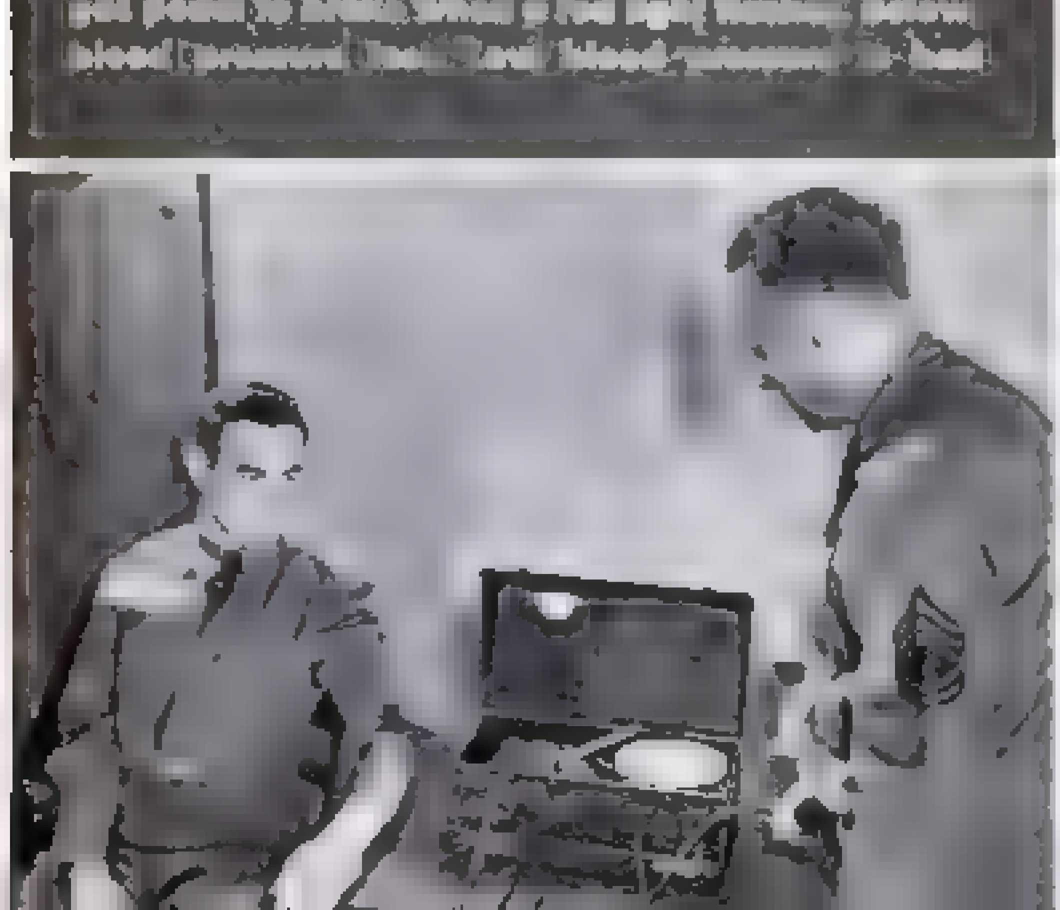
build the charge. Reports from the Russian front indicate that one of the prime causes of the German reverses last winter was breakdown of motor transport, and that battery failure was very common. Tests have shown that a run-down battery may freeze at 20 degrees above zero while a similar battery, fully charged, can withstand cold as great as 85 degrees below zero.

In any case, it is regarded as routine now that when any sizable U. S. troop unit is about to go into action, all its motorized equipment must be battery-tested, both for charge and probable remaining life, and unsatisfactory batteries must either be charged or replaced by new ones. Portable testing and charging units have been developed for field use, and the pride of the collection is the little hot-shot 100-ampere charger which can roll along the line, slapping the charge into each weak-sister battery in five minutes or less. A thermostatic control prevents overcharging.

Equally ingenious is the portable air pump, a small gas engine and air compressor, set in a tubular steel frame and made to be trundled along the truck line, wheelbarrow fashion. You can look it over for the air tank, but you won't find any; the tubular frame itself serves as the air reservoir.

The ignition and circuit testers illustrate the campaign for simplified and standardized equipment. Ultimately the Army plans to have completely standard repair outfits, so that any trained soldier, working with any repair group, will know that the low-voltage circuit

DRIVER TEST: [illegible] gas pedal to brake when a red light flashes, below blood pressure [illegible]



How side vision is measured. The driver being tested, focusing on target, indicates when he can see piece of white chalk moved out along the periphery of the board

SIDE VISION, the ability to see to the side when the eyes are focused on an object directly ahead is important to the pilots of Army trucks. With 90-degree vision on all sides, driver would not see truck until too late

tester, for example is to be found in the lower left drawer of Cabinet X in Truck 3 The tester will be standard throughout the Army, and the inside of the case lid will carry basic instructions and a wiring diagram, permanently etched in metal

Months ago, when the whole Preventive Maintenance program was in the early stage of development, officers in charge of the plan ran a quiet survey of their own asking a number of field officers, "What do you need to make your motorized equipment work better?" Almost invariably the answer came back, "More spare parts!" It was plausible, but not entirely practical One typical Army car, the 2½-ton truck has exactly 2,997 parts, of which about 1,900 are necessary for the operation of the vehicle. The Army has some 80 makes and models of cars, and among them they have around 2,400,000 parts quite a bundle for any repair crew

The motor-vehicle officers tackled the problem from a different angle, suggesting a joint inspection of the cars in question More often than not the search turned up dirty air cleaners, clogged oil filters, low oil level, batteries run dry, tires too soft or too hard, wheels out of alignment, or a score of other evidences of sloppy maintenance and lightweight inspection which went a long way toward accounting for that voracious appetite for spare parts

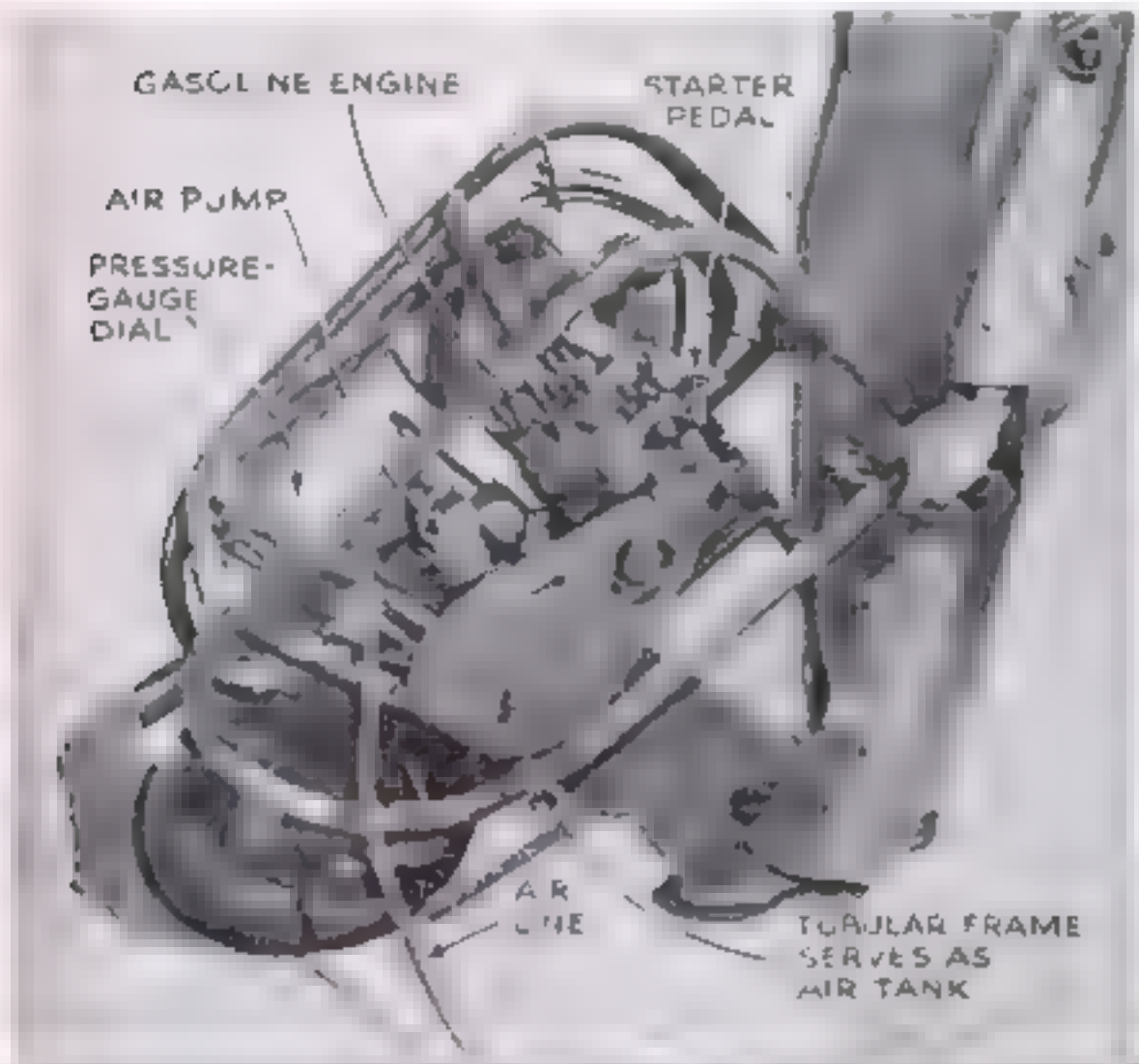
The real drive for indoctrination of officers and men in Preventive Maintenance theory dates from that time. It was pushed vigorously by *Army Motors*, a sprightly publication at the Holabird Base, and was taken up by other Army papers, among them the *Infantry Journal*

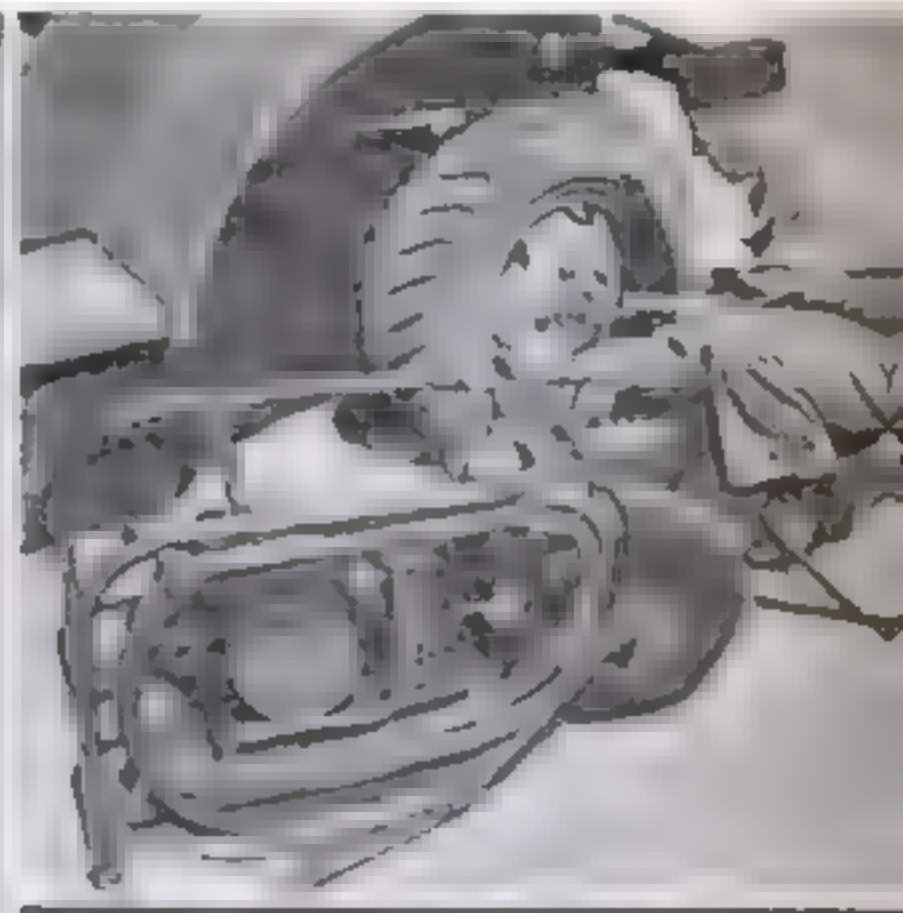
Driver selection and training, in particular has been stressed from the beginning It is a surprising fact that a very large majority of the young men coming into the Army have never driven a car and many of those assigned to motor transport work must be taught the fundamentals of driving before they can tackle the advanced course

A model course in advanced driving techniques developed at Holabird includes convoy and cross-country driving and operation of motor vehicles under blackout conditions.

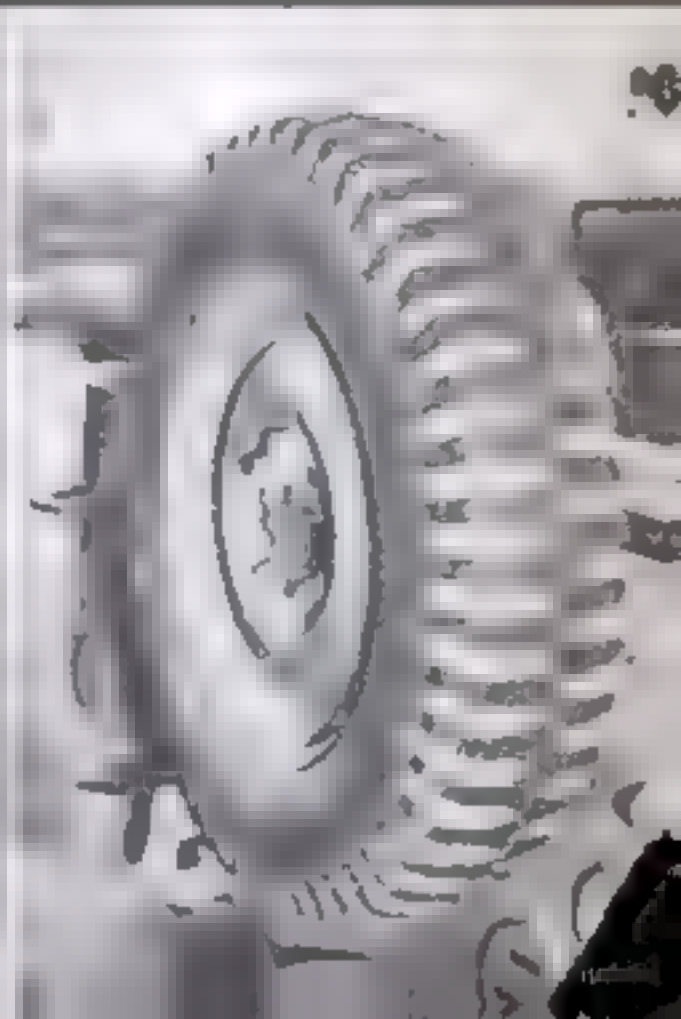
Selection of the likeliest candidates for this training is a special problem in itself. Studies have been undertaken to obtain a series of carefully graded physical and psychological examinations which should reflect a prospective Army driver's fitness for the job. These tests were prepared by the outstanding personnel technicians in this field. The results of this group study are being co-ordinated and applied by Dr. Leon Brody, formerly of New York University's safety center.

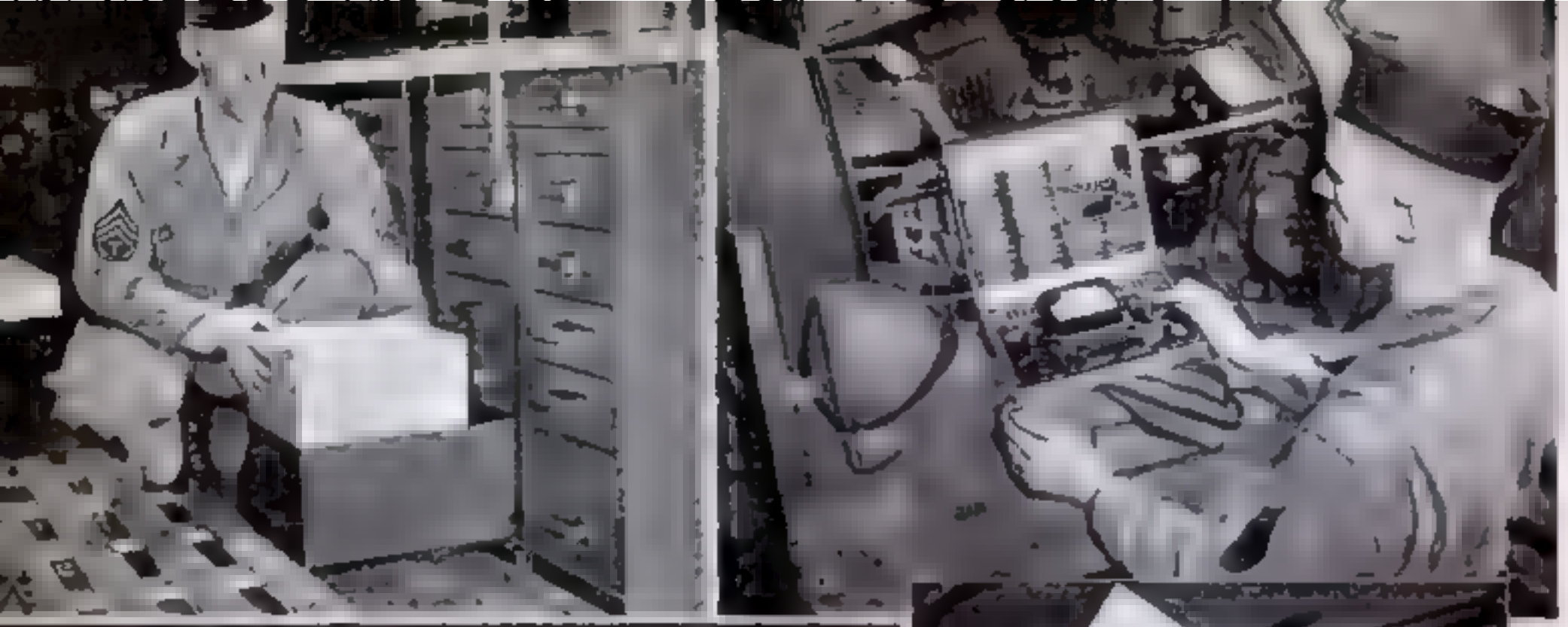
Eyesight, of course, is a very important factor for any driver. But in addition to the normal tests for sharpness of vision, it has been found advisable to run special tests to weed out men who see well straight ahead



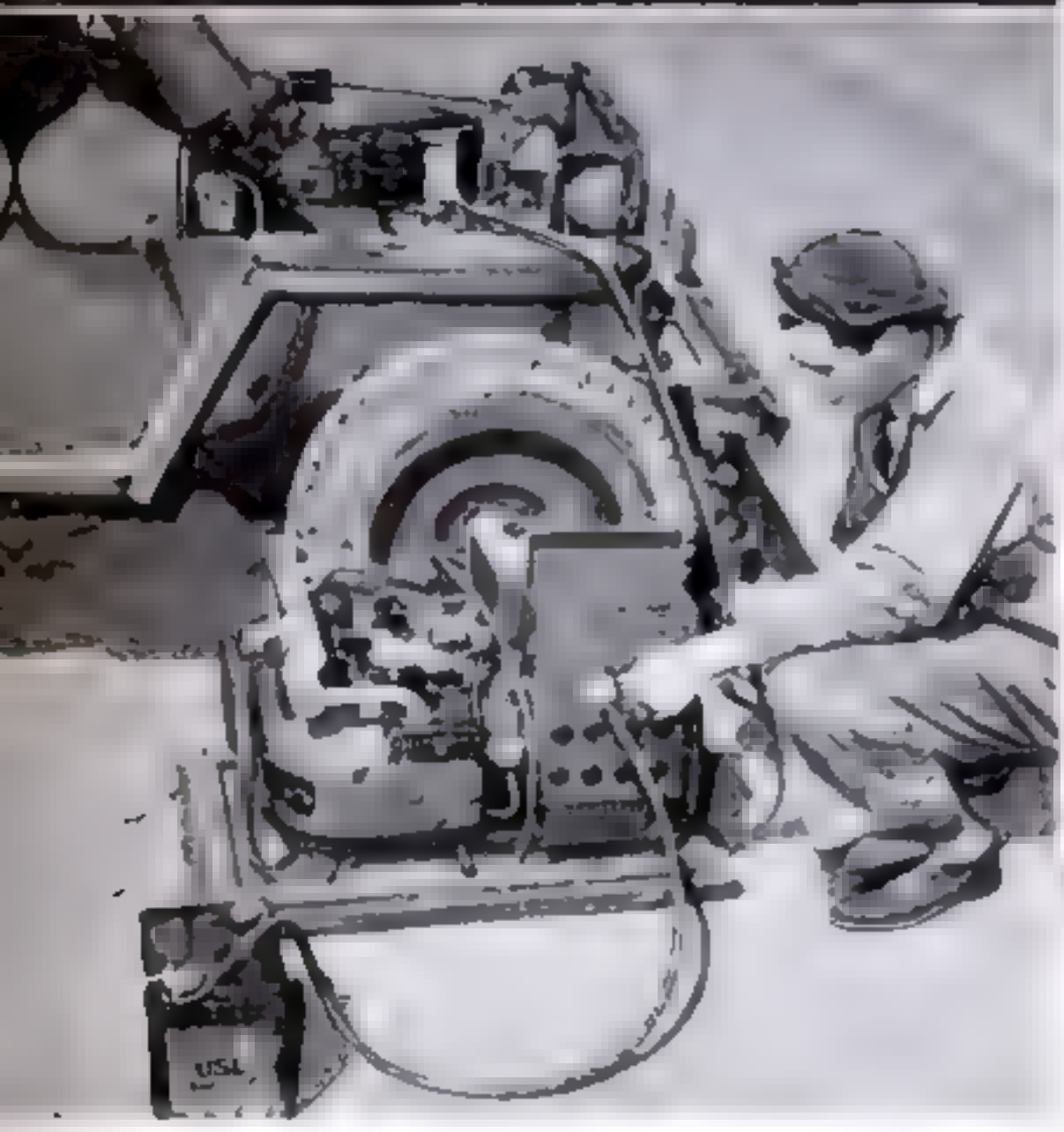


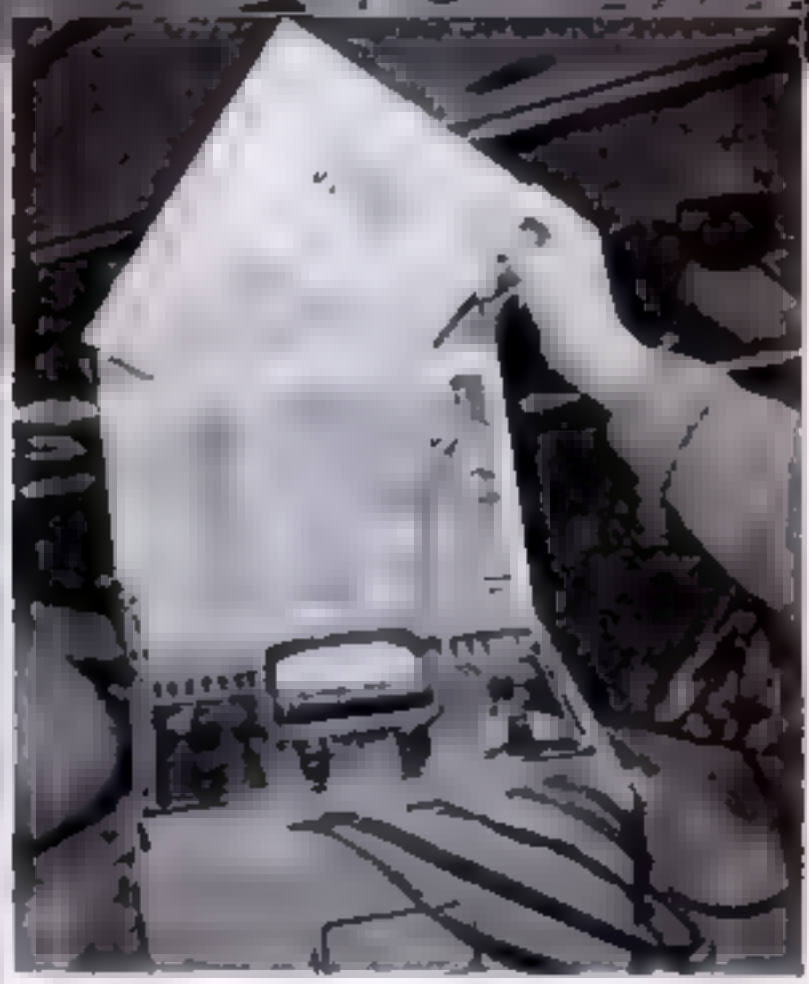
MORE SIMPLIFICATION





STANDARDIZATION. A good example of the equipment standardization program that is part of "preventive maintenance"—the low-voltage tester above and at right. It will be identical throughout the Army, even to its storage place.





BATTERIES are important to truck convoys, so portable chargers follow along in repair trucks. For a battery that must be revived quickly there is a hot-shot charger capable of bringing it up to snuff in five minutes.

but suffer from "tunnel vision"—inability to see out of the side of the eye. "Night blindness," another eye defect, is known to be associated with Vitamin A deficiency, men who have trouble in blackout driving are fed vitamin concentrate, and the weakness sometimes clears up in as little as 48 hours.

Blood pressure has been found to have considerable influence on a driver's physical reactions. Records gathered in the New York area showed that of accident "repeaters" who were given physical examinations, 48 percent had low blood pressure. The Army now sets an allowable range of 105 to 145 for men between 18 and 35 years old.

Laboratory equipment for driver examination may include a distance-orientation device, in which the man is required to bring two pointers into line equally distant from his sighting point, and a reaction-time indicator, in which he must shift his foot from a simulated accelerator pedal to the cor-

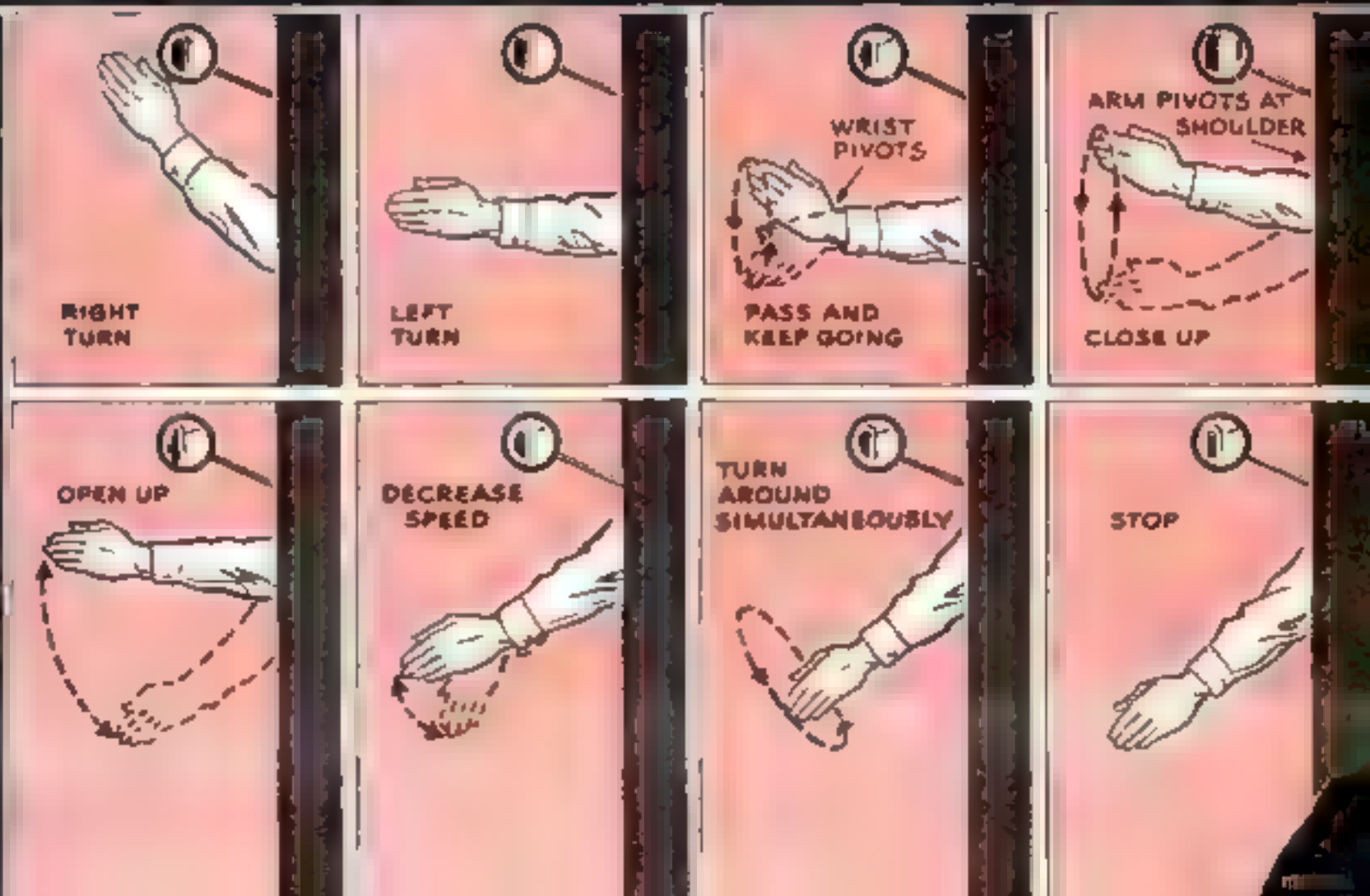
responding brake pedal when a light signal flashes. Failure to react is rated an error; a study of several thousand 'good' drivers disclosed six tenths of a second to be the average reaction time on this test.

Finally, a man's mental attitudes are important. In general it appears unwise to select either a man of very high or very low mentality. The slow thinker won't meet new situations or problems with enough speed and judgment, while the intellectual is apt to day- *Continued on page 202*

HAND SIGNALS CONVEY ORDERS TO ARMY DRIVERS

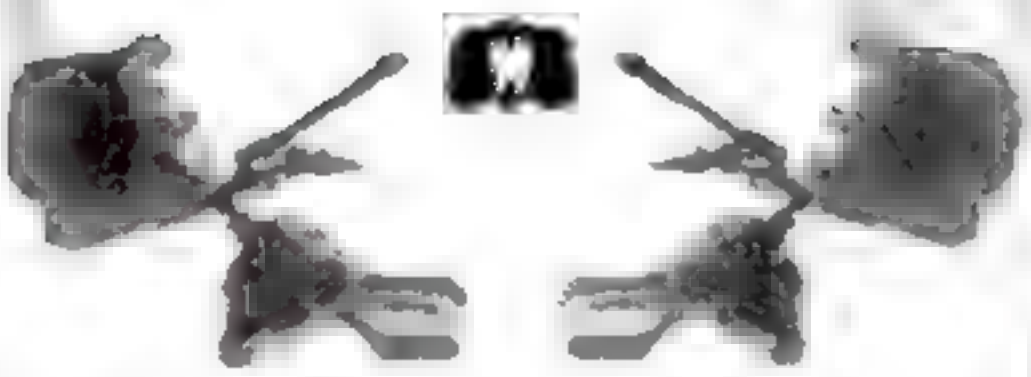
HOW DRIVERS IN A CONVOY TALK TO ONE ANOTHER

These eight signals are now standard with the Army. They form the basis for what may become a nation-wide code for civilian drivers as well.



INK BLOTS TEST

Fantastic Shapes Help



What is it? Your answer may show your aptitudes

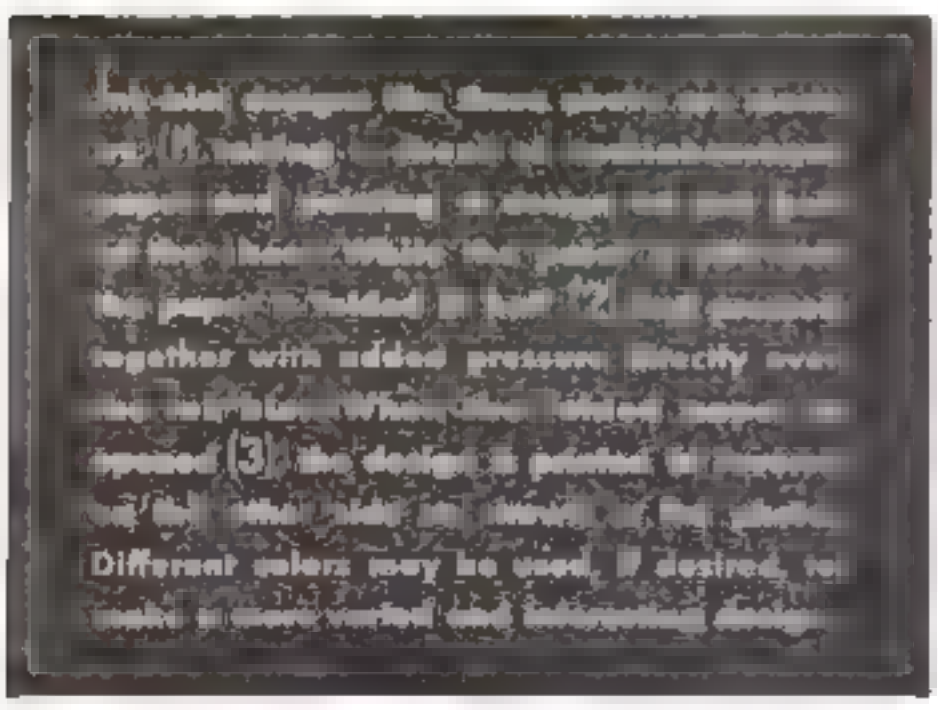
BY PROJECTING a series of carefully prepared ink blots on a screen and asking spectators to write down what each fantastic shape suggests, psychologists are now able to choose suitable men for mechanized units of the armed forces, and workers for industrial jobs.

Incomprehensible as this technique may seem to the layman, predictions made by the new test are said to have been remarkably successful in its first tryout. In a recent test group of 78 young men in a group of shops, 73 were properly classified according to their value to the shop.

Ink-blot tests, developed nearly 20 years ago by a Swiss psychiatrist named Rorschach, were, until recently, used as a means of carefully diagnosing neurotic or psychotic conditions. The new projection method, which allows as many as 100 to take the test at one time, has been revised to give a quick picture of the individual's reactions in normal life.

Each person taking the examination is given ten sheets of plain white paper. After a brief explanation as to the procedure they are to follow, an ink blot is projected on the screen. During the next three minutes, the subject studies the slide and writes down just what the ink blot represents to his imagination. The same procedure is followed through a series of ten black-and-white and colored slides.

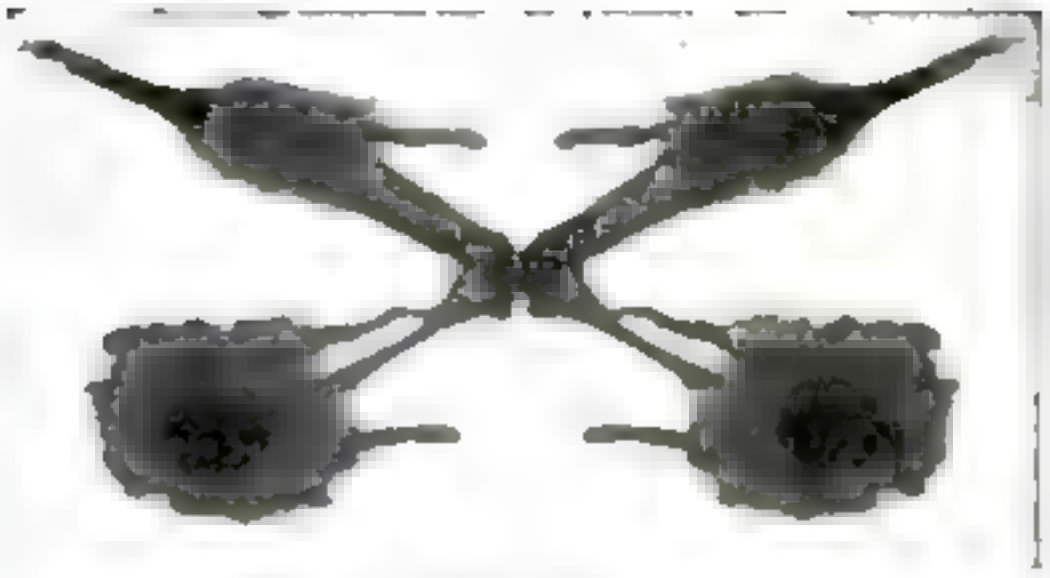
Most people would call this a Floradora girl with two pet peacocks—a "popular" response



YOUR SKILLS

Pick Men for War Jobs

If you share these popular responses, it shows that you see things as many other people do



This design suggests different things to different people

Many different answers may be suggested by any one of the ink blots and none are right or wrong, but certain ideas are more frequently given than others. For instance, the most natural reaction to the colored plate at the left is to think of a "gay nineties" dancing girl. The red objects on either side might represent peacocks. Every person should have a certain number of these "popular" responses which indicate his ability to see things as other people do.

In scoring the test, examiners are particularly careful to notice whether the subject has observed color, movement, form, or texture. They note just how far the imagination has roamed and whether there is any particular resemblance to the object described. Both the number and kind of whole responses and the number of minute details used may give clews to a neurotic personality, although other signs also must occur before such a diagnosis can be made.

All these points totaled up give the examiner a pretty clear picture of how the individual will act in time of stress, what his energies and abilities are, and how he can use them in his environment.

The new method of presenting ink-blot tests was devised by Miss B. Candee, a psychologist at the National Youth Administration office in New York, and Dr. Z. Piotrowski of the Psychiatric Institute, New York.

HELMETS.. a Medieval Note in Modern War

ITAL. BARBUTE
1400-1500

SALLET & BEVOR
GERMAN - 1480

AUGSBURG HELMET
1500-1600

ENGLISH SIEGE
1500-1700

BRITISH STANDARD
1918

FRENCH STANDARD
1918

Best of all modern military helmets is the U. S. Army's M-1. It is a greatly improved pot-style helmet of steel that is worn over a field hat of fiber fitted to the head by a football helmet suspension.

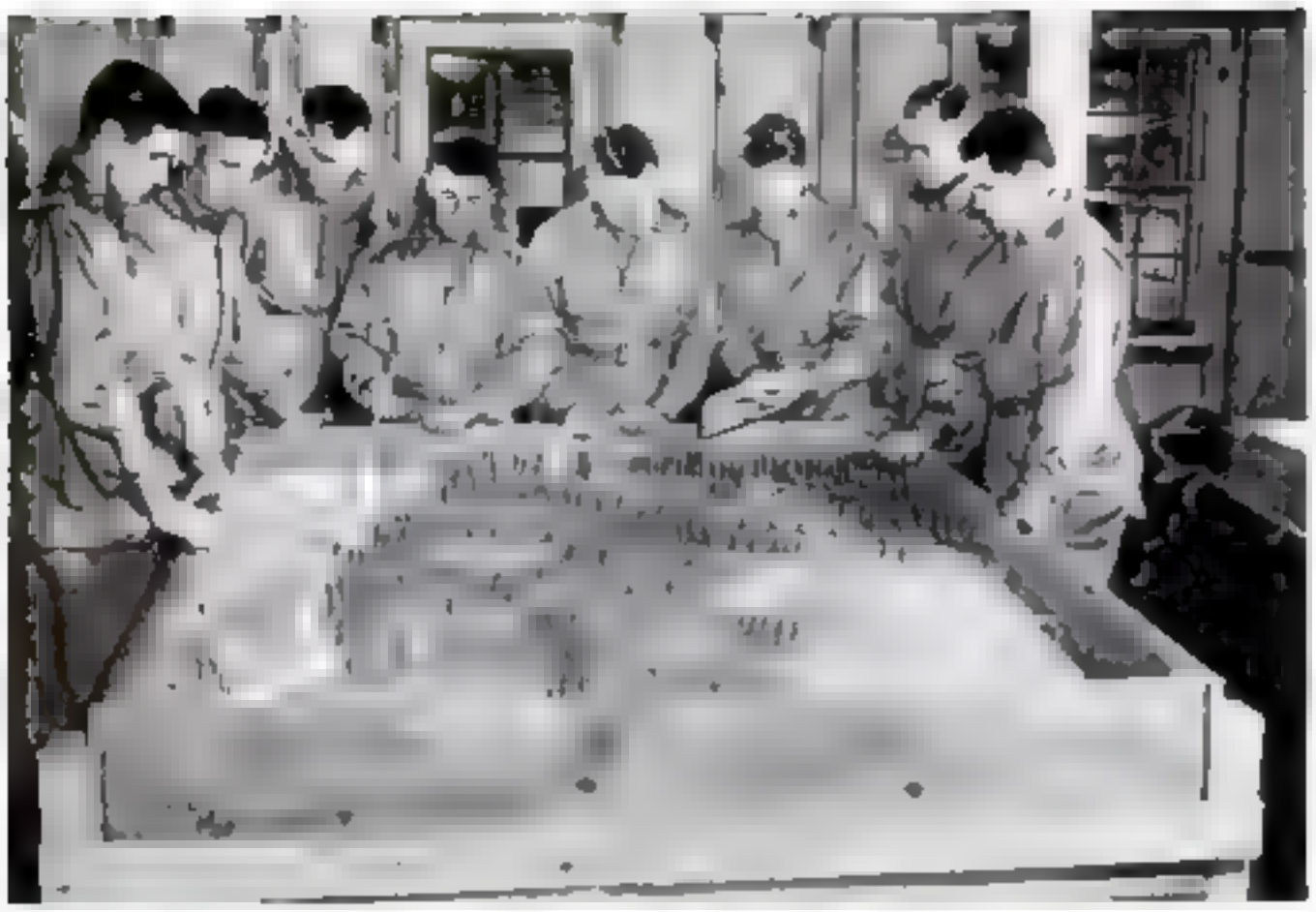
Our artist's conception of a giant 250 000-pound transport plane, of a type already on the designers' boards, landing troops on a beach

Winged Attackers

AIRBORNE TROOPS PRESENT A NEW TECHNIQUE IN WAR. HERE ARE THE FACTS ABOUT ITS DEVELOPMENT TO DATE

THE greatest military innovation of this war is the use of airborne troops—parachutists, glider troops, and air-landed infantry. Its development to date, no less than its possibilities, tends to outrun the earth-bound imagination. But little about the actual operations of these troops filters through the news censorship to feed our understanding.

This article sets forth some of the basic developments in airborne fighting, on information from sources outside routine war

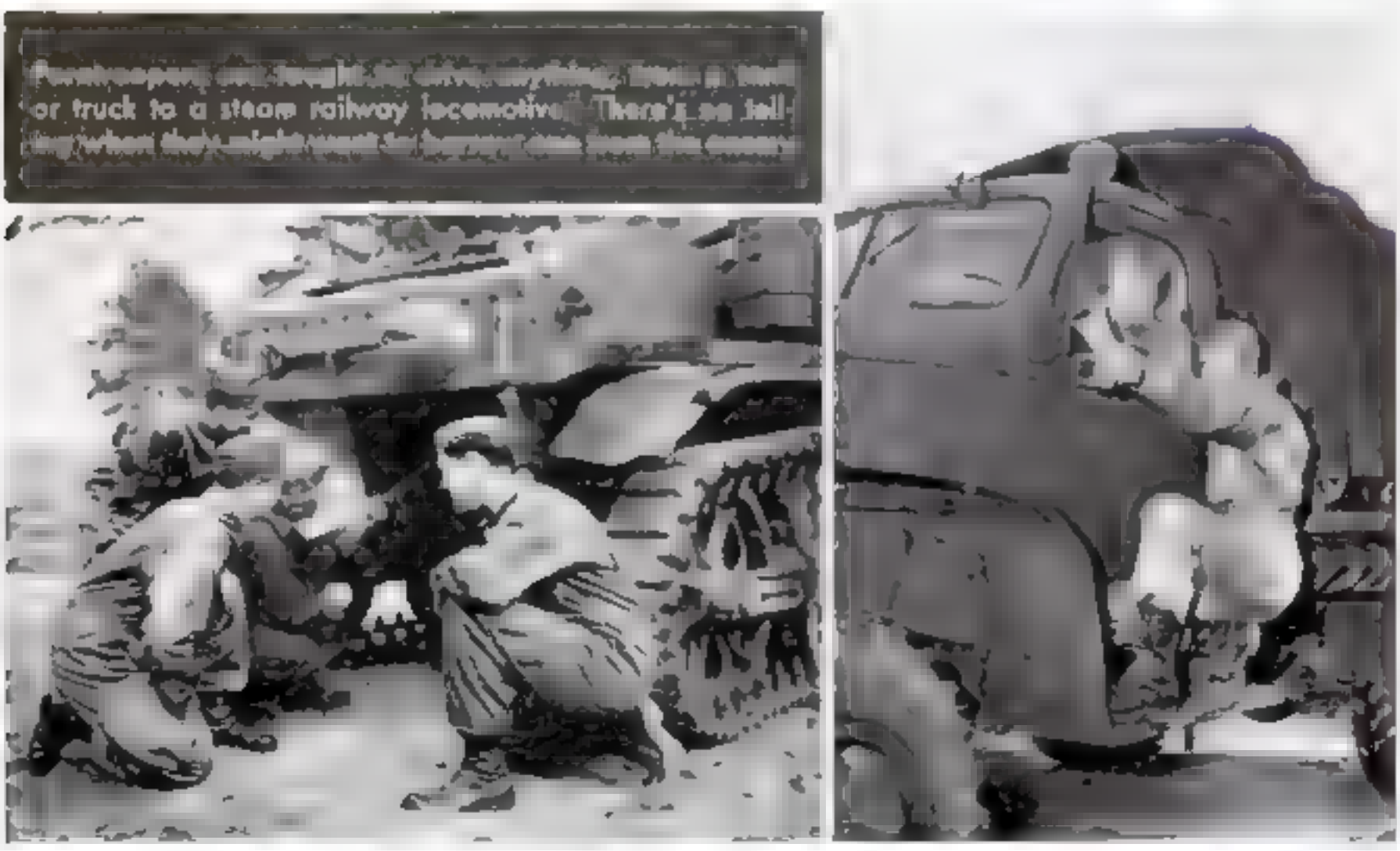


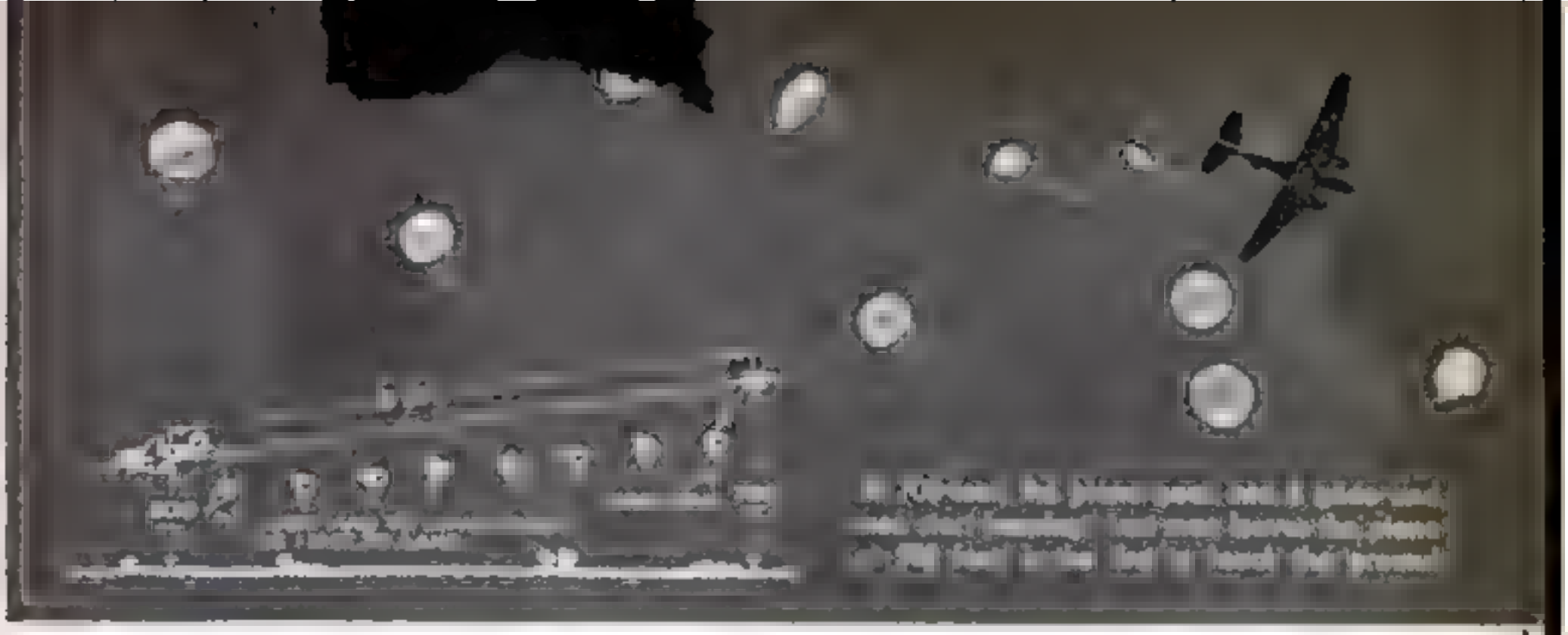
Studying tactical sandbox models like this help teach air troops to recognize the key points of the terrain in which they are to operate while in training

correspondence. These techniques originate largely with the Axis, for the simple reason that this kind of operation cannot even be undertaken without air superiority. But United Nations air domination is on the way, and this type of fighting will take on increased importance for us, as a means of attack as well as a danger to guard against.

The three types of air troopers have their special purposes in the attacking combat team, and their differences in training, but one thing they have in common: they are utterly dependent on the maintenance of local air superiority, a protecting canopy of fighter planes. They arrive in vehicles as defenseless as clay pigeons, and so do their supplies and reinforcements. Let us take up the three types of troops one by one and see what their purposes, training, and capabilities are.

As a vehicle for the air trooper, the glider has many points of superiority over the parachute. It can be big enough for two dozen men, and towed three or more behind one power plane, either in train or harnessed in V formation. Approaching at great height, released 20 miles or more from the objective, the gliders sail in silently and fast, landing simultaneously at precise points picked out in advance on air photographs. A glider can land in any small open patch of ground, with cover close at hand, at a speed low enough that even a crash is not disastrous. An instant after the moment of impact, the troops are out, fully equipped and concentrating heavy fire on the enemy positions while parachutists landed at the same *(Continued on page 63)*





KEY TO BATTLE MAP ON FOLLOWING PAGES

AIRBORNE ASSAULT on strong ground positions is shown in its five phases in the drawing on the following page, as gathered from European sources. The key diagram below, divided into five areas corresponding to the five phases, will serve as a guide.

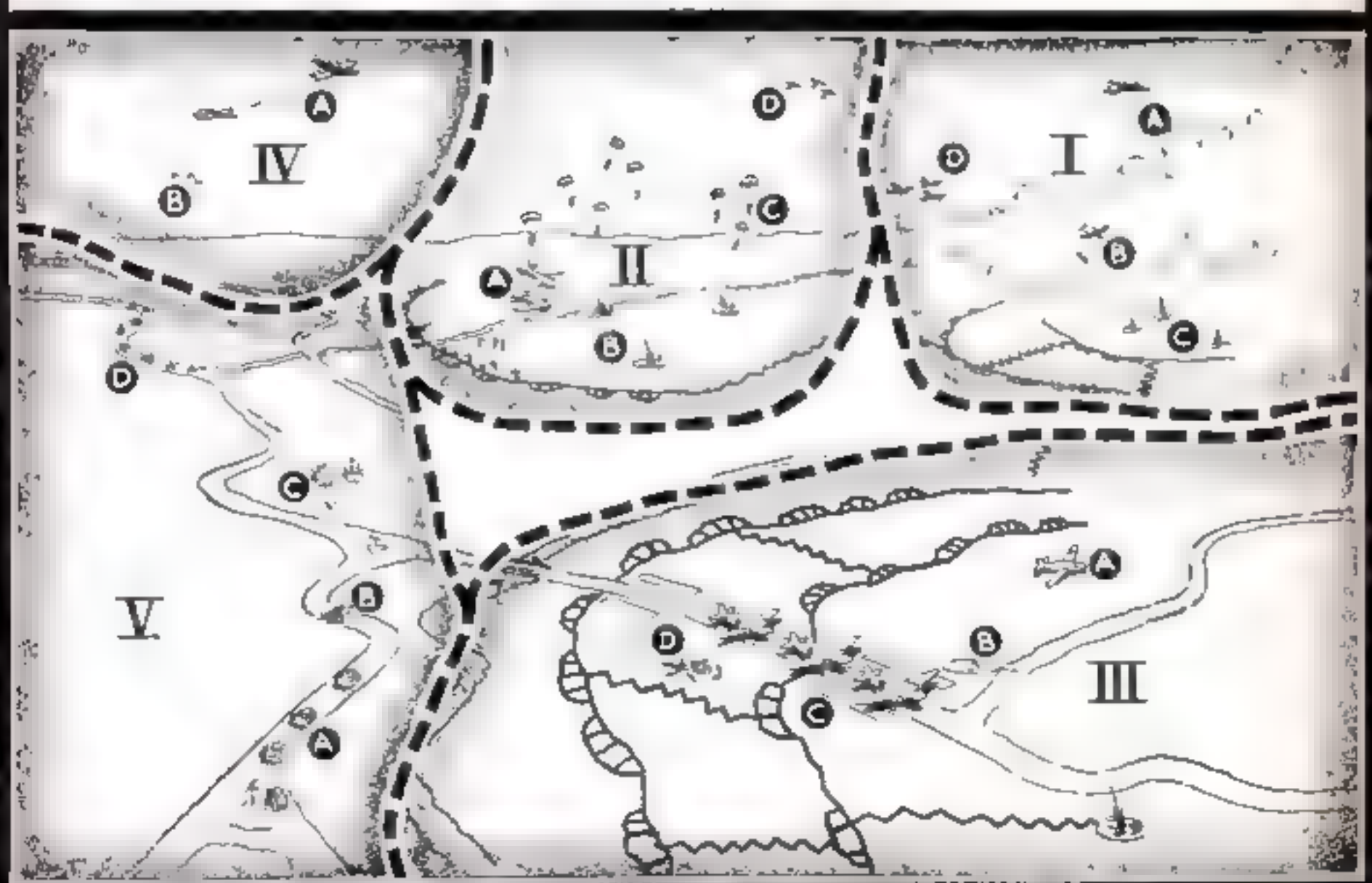
AREA I: Air bombardment begins the reduction of the strong point, with horizontal bombers (A) and dive bombers (B) blasting the defenders' antiaircraft guns (C) and other ground defenses. Just as the bombers finish their work of destruction, the troop-carrying gliders (D) slide in to a landing.

AREA II: Here the gliders (A) have landed and their troops, using the weapons they have brought with them, are mopping up the antiaircraft units (B) that survived the bombing. While this is going on, parachutists (C) dropped by large transport planes (D) hit the ground and immediately go into action helping the glider troops to overwhelm any resistance and to clear the way for planes to land.

AREA III: Men brought by gliders (A) and parachutes (B) now are joined by air landing troops borne by cargo ships (C) which have been guided in landing by white cloth panels laid on the ground. Fire power is increased by light field guns (D), antiaircraft machine guns, and other weapons dropped with parachutes of distinctive colors and quickly assembled. The cargo planes bring 37-mm. and 75-mm. antitank guns, jeeps, and engineer troops to help prepare for the inevitable enemy counterattack.

AREA IV: Meanwhile, more weapon-carrying gliders (A) and cargo planes (B) swarm into the captured areas. They either land on roads and fields or crash-land anywhere to put their troops aground.

AREA V: Mechanized reserves (A) rushed up by the defenders encounter log tank traps (B) hastily constructed by engineers and find the roads covered by airborne antitank guns (C). Meanwhile, supporting ground forces (D) come up to help the attackers.



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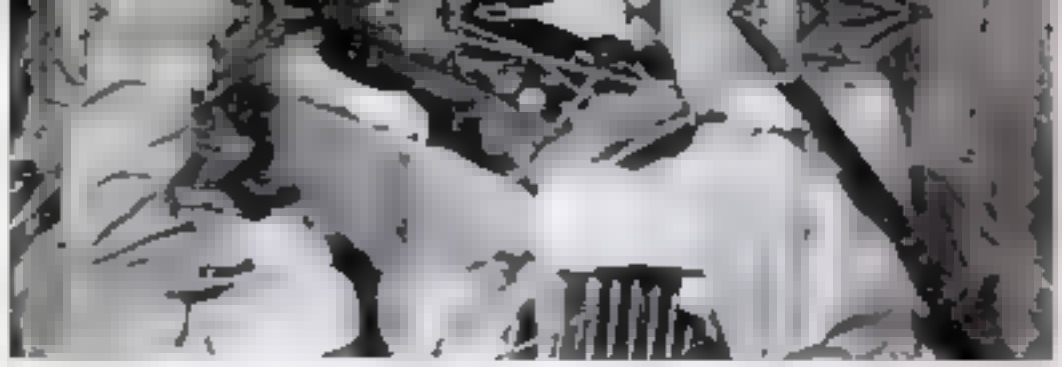
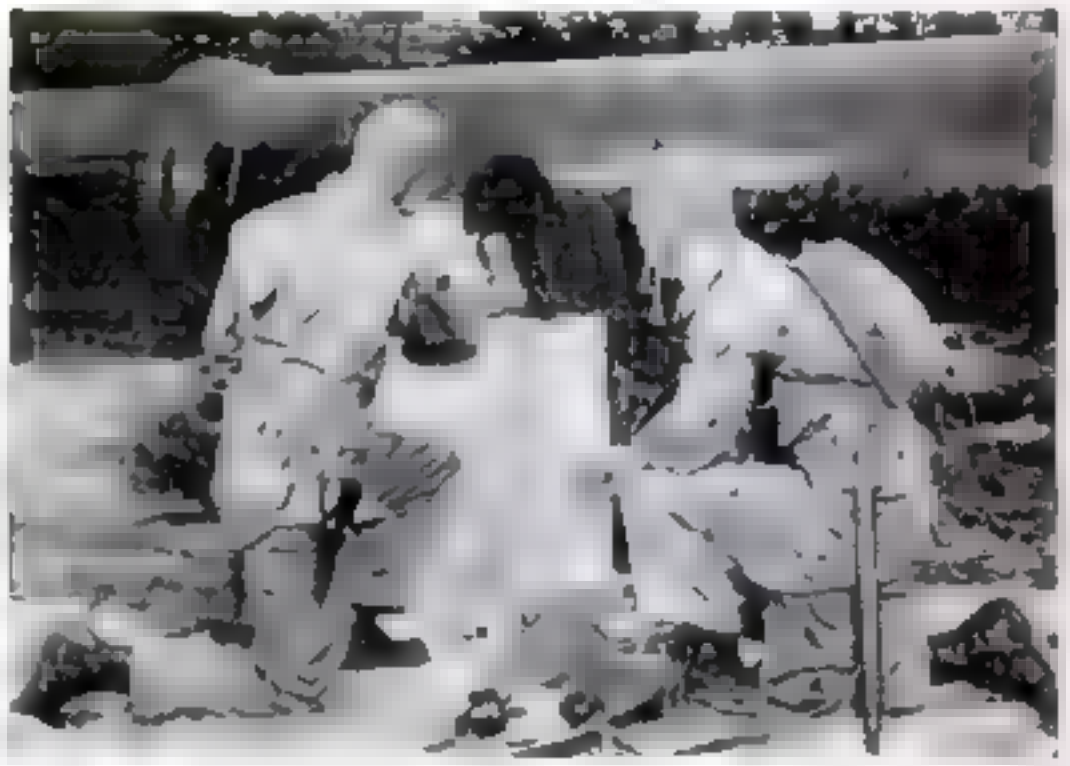
DEMOLITION

Specially trained demolition men attached to parachute units carry kits of high explosives on their backs. At the right, two of them show how a "necklace" of explosive blocks would be applied to a pipe line to cripple the enemy

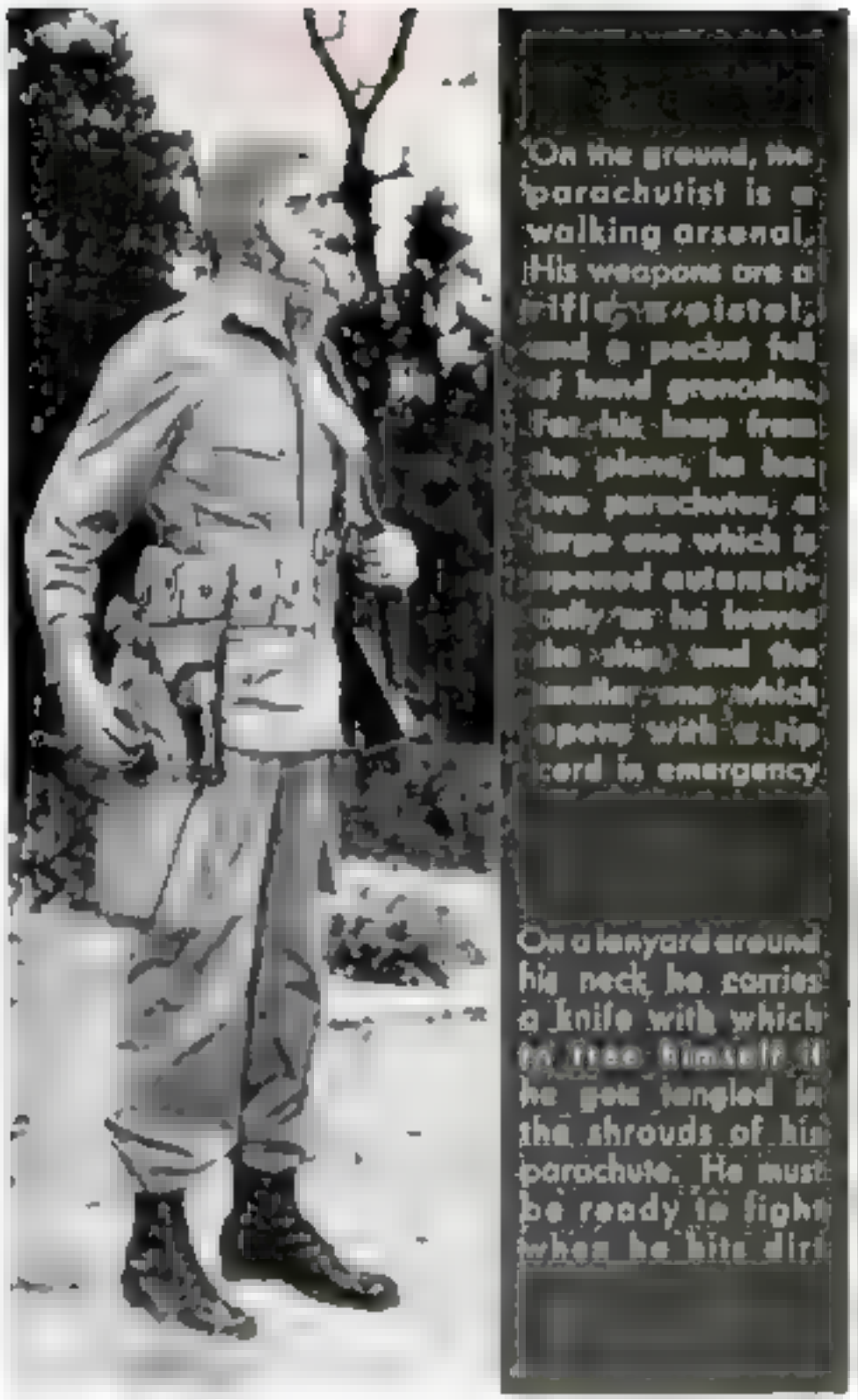


Captured vehicles may be totally wrecked, or merely put out of action so they can be used later if needed



FIRST AID

At the left, the medical man directs two comrades in giving aid to a man with a broken leg



instant, no matter how daring and skillful, would still be picking themselves up and collecting their equipment.

The glider troops can and do carry heavy equipment. With a big enough door, the ship can carry a fully assembled field gun as well as an equal weight of men. Glider troops are heavily freighted with mortars, machine guns, antitank guns, and other high-powered instruments of destruction.

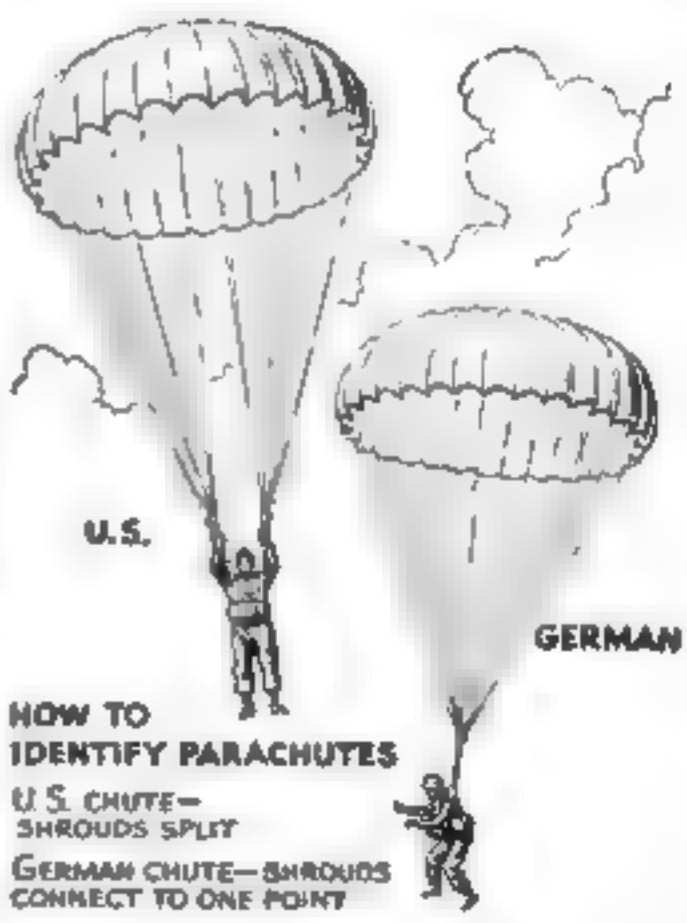
Another advantage of the glider is that it is relatively simple to learn how to sit tight in landing, and then bail out on the ground ready for combat. A parachutist must spend much time and effort simply training in the technique of jumping, which is of no use to him after landing. The glider men can spend much of this time in knitting *(Continued on page 214)*

HOW TO IDENTIFY ENEMY GLIDERS, TUGS, PARACHUTES

DFS 230 GLIDER. High-wing monoplane of 71.5-foot span. It can carry 10 fully equipped men including pilot. Total disposable load, 2,800 pounds. May mount an infantry machine gun

GOTHA 242 GLIDER. Twin-boom monoplane with central nacelle holding 23 men including two pilots. Span, 79 feet; 52.5 feet long. Four machine guns. Freight capacity, 5,300 pounds. Nacelle, 37 feet long, is constructed of tubular metal

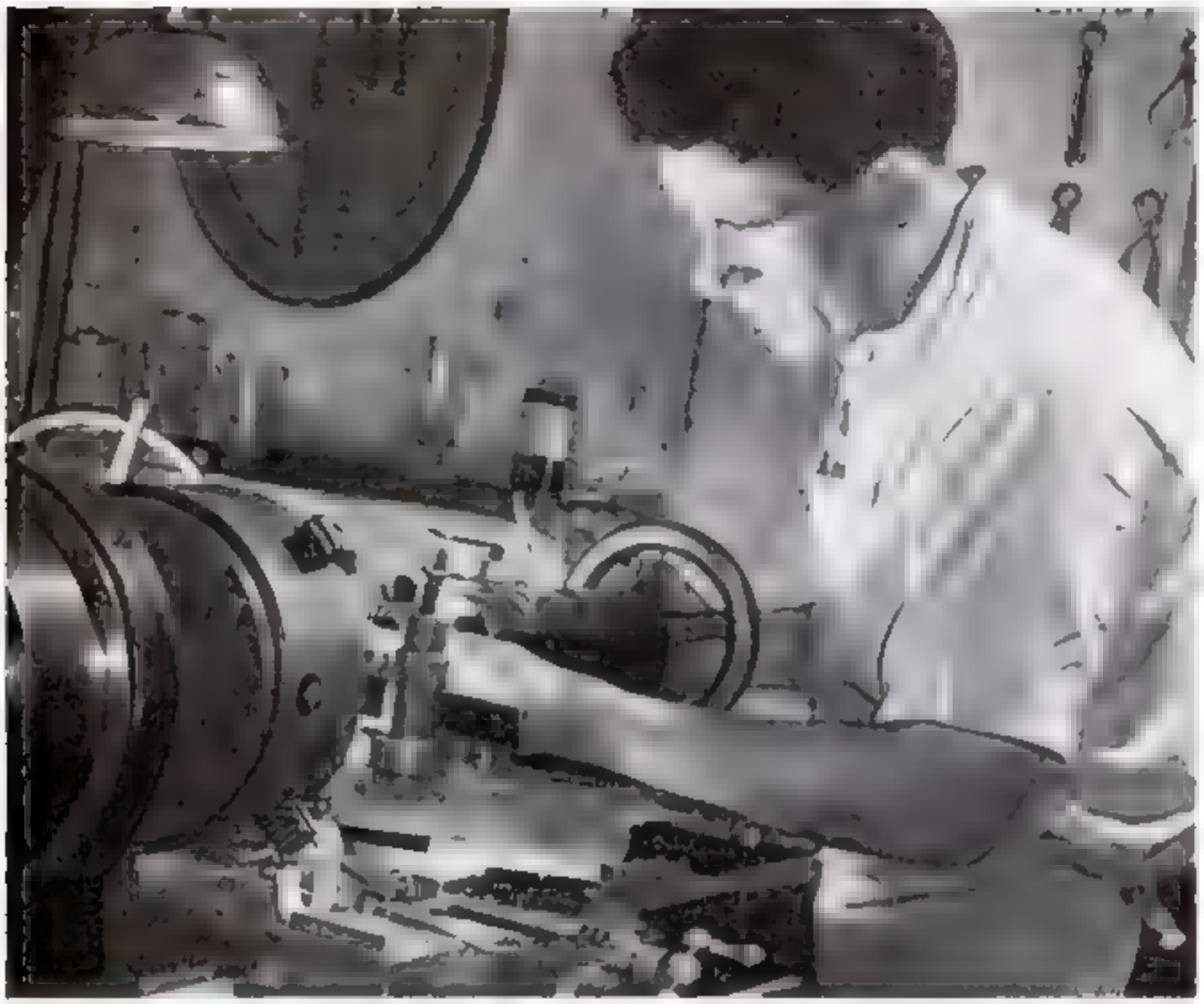
JUNKERS GLIDER TUG. A three-engine, low-wing, cantilever monoplane. Also used for cargo and troop transport. Has crew of three and carries two or three 7.9-mm. guns. Its top speed, 195 m.p.h. at 8,000 ft.



HOW TO IDENTIFY PARACHUTES

U.S. CHUTE—SHROUDS SPLIT

GERMAN CHUTE—SHROUDS CONNECT TO ONE POINT



WHAT YOU CAN DO FOR VICTORY

SUBCONTRACTING SPEED-UP BRINGS WAR WORK TO MORE SMALL SHOPS

THE accelerating tempo of war production, with its vast demands for machines and skilled workmen, has resulted in urgent appeals on the part of the War Production Board for increased subcontracting of work to the smaller shops of the country. This is in line with the survey being conducted by POPULAR SCIENCE to uncover unused facilities and create a reservoir of small shops.

Every war manufacturer was asked by James S. Knowlson, director of industry operations for the WPB, at a recent meeting of leading Midwest industrialists, to find immediately five new subcontractors to add to his list.

"It is a proud moment for all of us," he said, "when we can say: 'There isn't an idle tool in our plant'; but it will be a much prouder moment when each of us will be able to say: 'I don't know of an idle tool in the community.'"

Through its war-work registration, POPULAR SCIENCE is co-operating with the WPB to increase subcontracting. Any reader who has a well-equipped home workshop or any type of small shop suitable for producing "bits and pieces" can help, if he has not already done so, by registering in this survey. Send a stamped, self-addressed envelope to War-Work Registration, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York, and ask for a registration form and instructions. Don't put it off! Act at once . . . write today.

In an old blacksmith shop tucked behind tenements of an eastern city, Michael Freed (above) and four helpers do Navy work and make ammunition tools

How About Synthetic Rubber?

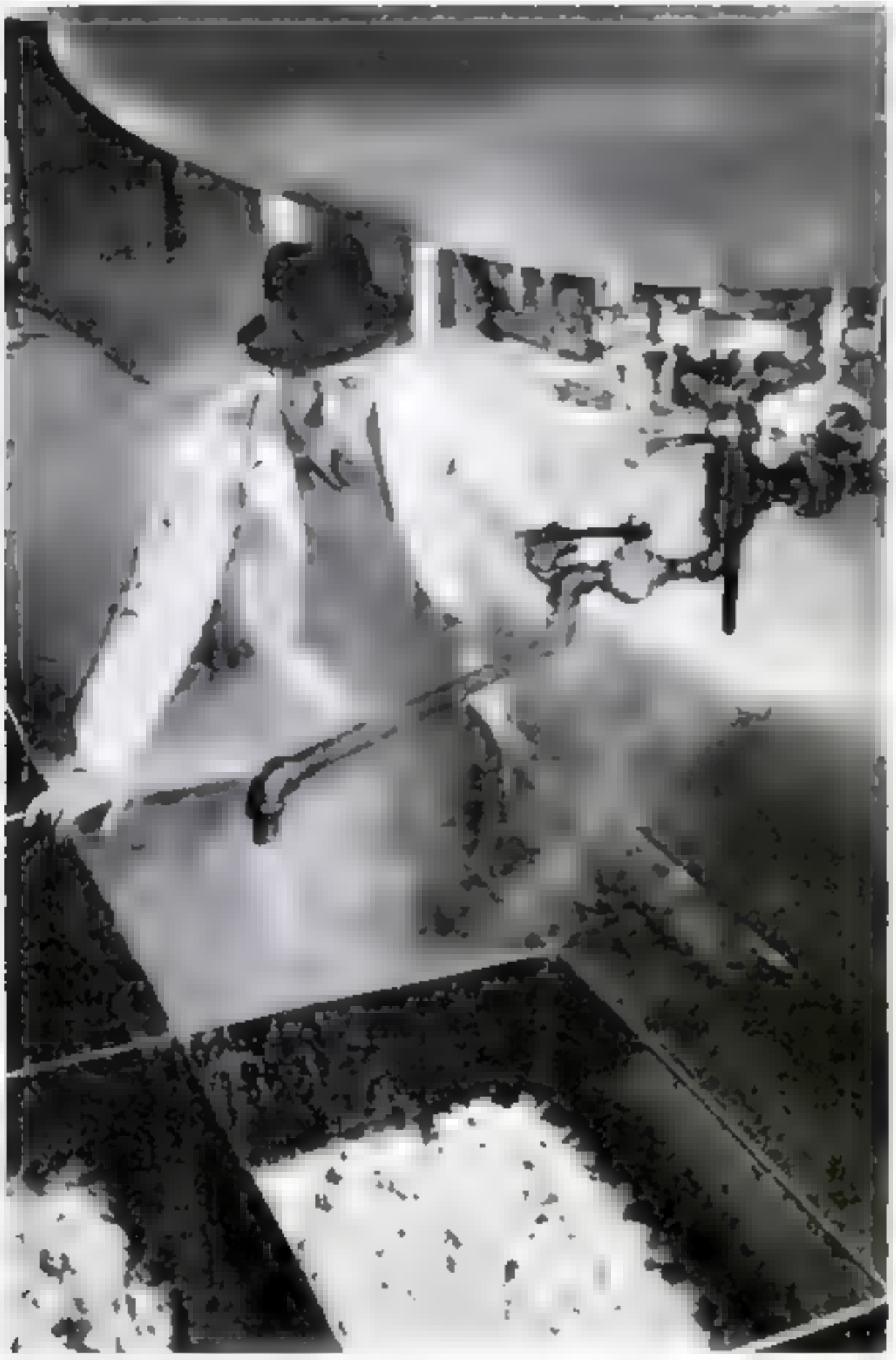
THIS ARTICLE WILL ANSWER ALL YOUR QUESTIONS ABOUT THE PRODUCTION OF RUBBER FROM PLENTIFUL PETROLEUM

By CARL DREHER

THERE is a rubber shortage but no shortage of the raw materials from which rubber can be made. We wasted those materials before the onset of the present struggle. It was not "economical" to make them into rubber or rubberlike compounds because natural rubber was much cheaper and readily available in the East Indies. When the Japs moved in, the situation changed almost overnight. But overnight we can't make hundreds of thousands of tons of the stuff in converted teakettles. Mass production requires hundreds of thousands or millions of tons of plant and machinery. Part of it we have. The rest we must build.

Talk of a rubber shortage and people automatically think of their automobiles. But a situation like this takes in far more territory than the automotive field or transportation in general. Every single industry depends on rubber in one way or another. While we are using up our stockpile of 700,000 long tons (a long ton equals 2,240 pounds) of natural rubber, we shall make the rubber we need, or its equivalent, out of whatever we can lay our hands on—and that means principally petroleum and petroleum derivatives.

We can make rubber from petroleum because both are members of the vast chemical family of hydrocarbons—carbon and hydrogen in combined form. Natural crude rubber, as it is bled from the tree, is over 90 percent hydrocarbon. The essential hydrocarbon portion is called *isoprene*, a watery liquid with a



Rubber from oil. Resembling natural latex, this synthetic liquid rubber is created from a by-product of aviation-gas manufacture

[illegible]
Parent material for natural rubber is the rubber tree's iso-
prene, with five-carbon-atom molecules which nature links
in long chains. Man links four-carbon-atom molecules of
butadiene by combining them with other chemicals. The
two now most used, to make buna and butyl rubber
[illegible]

low boiling point and the chemical composition C_5H_8. Petroleum, in contrast, is not a single hydrocarbon, but a mixture of many such as gasoline, kerosene, fuel and lubricating oils, paraffin oils and the like, and the heavy bottoms (asphalt, etc.). Sixty-two hydrocarbons have been identified in the gasoline and kerosene fractions alone.

What matters in rubber is not so much the chemical elements as the arrangement of the atoms of those elements in the molecule and the size and weight of the molecule —structural factors, in short. We do not know exactly what happens to the molecules when latex, which is liquid rubber, becomes rubber in the solid, elastic form. But we do know that there are simple compounds called *monomers*, which have low molecular weight, and more complex forms of the same chemical elements in the some proportions, which are called *polymers*, characterized by higher molecular weight and entirely different physical properties. The change from one to the other is called *polymerization*, and the two forms are said to have a *monomer-polymer* relation. This is the relation which exists between isoprene or liquid rubber and a finished article like a rubber band. There is good reason to believe that the rubber band is elastic because it contains long linked chains of thousands of monomer units, the linking being accomplished by the polymerization process. These chains appear to run roughly parallel and to be loosely twisted.

The strength and durability of rubber are improved by *vulcanization*. Apparently vulcanization provides a crossbraced type of molecule, with sulphur atoms acting as tie pieces between adjacent chains. The monomer-polymer relationship and the effects of vulcanization are pictured in terms of atoms and molecules in the accompanying diagrams.

All this can be done with natural rubber —as long as you can get it. Alternatively, you can start with petroleum or other hydrocarbons, perform the same chemical tricks, and end up with a synthetic rubber better in some respects than the stuff nature turns out. For nature, after all, is interested only in providing something which will heal accidental cuts in a rubber tree. Nor did nature ever vulcanize rubber; that job she left for man to do.

It was a Russian, Lebedev, who first polymerized butadiene to form the type of synthetic rubber which at present has the greatest commercial importance. At the end of the First World War Germany was producing, with great difficulty and at excessive cost, 300 tons a month of inferior synthetic rubber; about the same production tonnage as we had in 1940, although our 1940 quality was no doubt far superior to the German 1918 quality. Nowadays both Russia and Germany depend largely on synthesis for their rubber and are getting satisfactory results. German production is estimated at 50,000 tons in 1941. We should get up to about that level this year, and in 1943 or 1944, with the expenditure of about a billion dollars, up to ten times that level.

The problem is essentially to get a "starting material" which contains something with four carbon atoms in a row, as shown at the right at top. It is characteristic of isoprene or natural rubber. Other such materials are butane (C_4H_{10}), butene or butylene (C_4H_8), and butadiene (C_4H_6). All of these four-carbon-atom substances may be derived from petroleum. Petroleum, however, is not the only possible source, and in Europe, where it is relatively scarce, various other starting materials have been used to yield butadiene, such as alcohol, acetylene, and coal.

Butadiene, however, is still a long way from rubber. It must be polymerized before it can exhibit rubbery properties. The original method of polymerization was by the use of sodium as a catalyst; that is, the sodium furthered the reaction without itself being used up in the process. This is the origin of *Buna*, the German trade name for the outstanding type of synthetic rubber. *Bu* stands for butadiene while *Na* is the chemical symbol for sodium (Latin *natrium*).

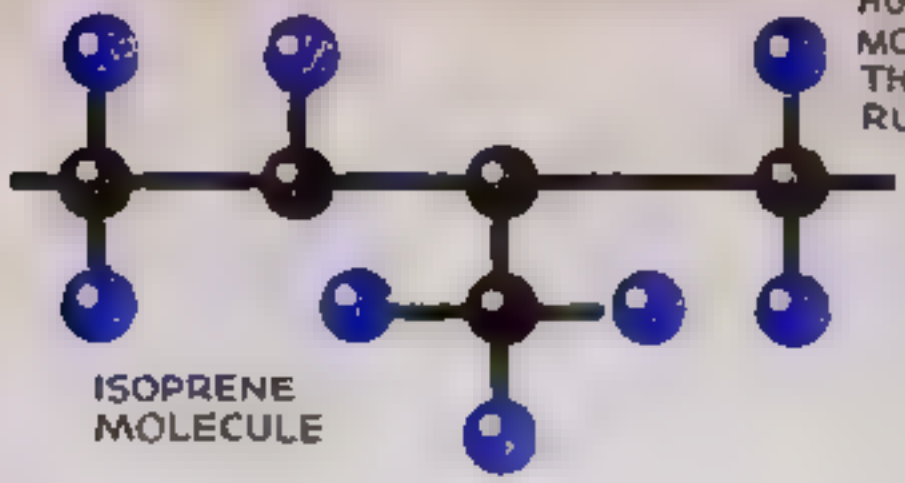
But polymerization with sodium required not only pressure and heat, but lengthy processing. So the Germans resorted to *emulsion polymerization*, which takes hours instead of days, and gives a cleaner, odorless rubber. This process utilizes principles and methods which have been developed by the chemists of all the leading industrial countries. The basic idea is to form an emulsion or soapy suspension in water, the action of which, in the presence of a catalyst under heat and pressure, will induce polymerization. Actually, the process now used involves *copolymerization*, that is, other polymerizable bodies are added to the butadiene and become a part of the rubber molecule with it. After treatment, the result is a synthetic latex or liquid rubber, resembling milk in appearance, which may be used for

NATURAL RUBBER

LINKED TOGETHER WITH HUNDREDS OF OTHER LIKE MOLECULES, OR POLYMERIZED, THIS BECOMES "NATURAL" RUBBER

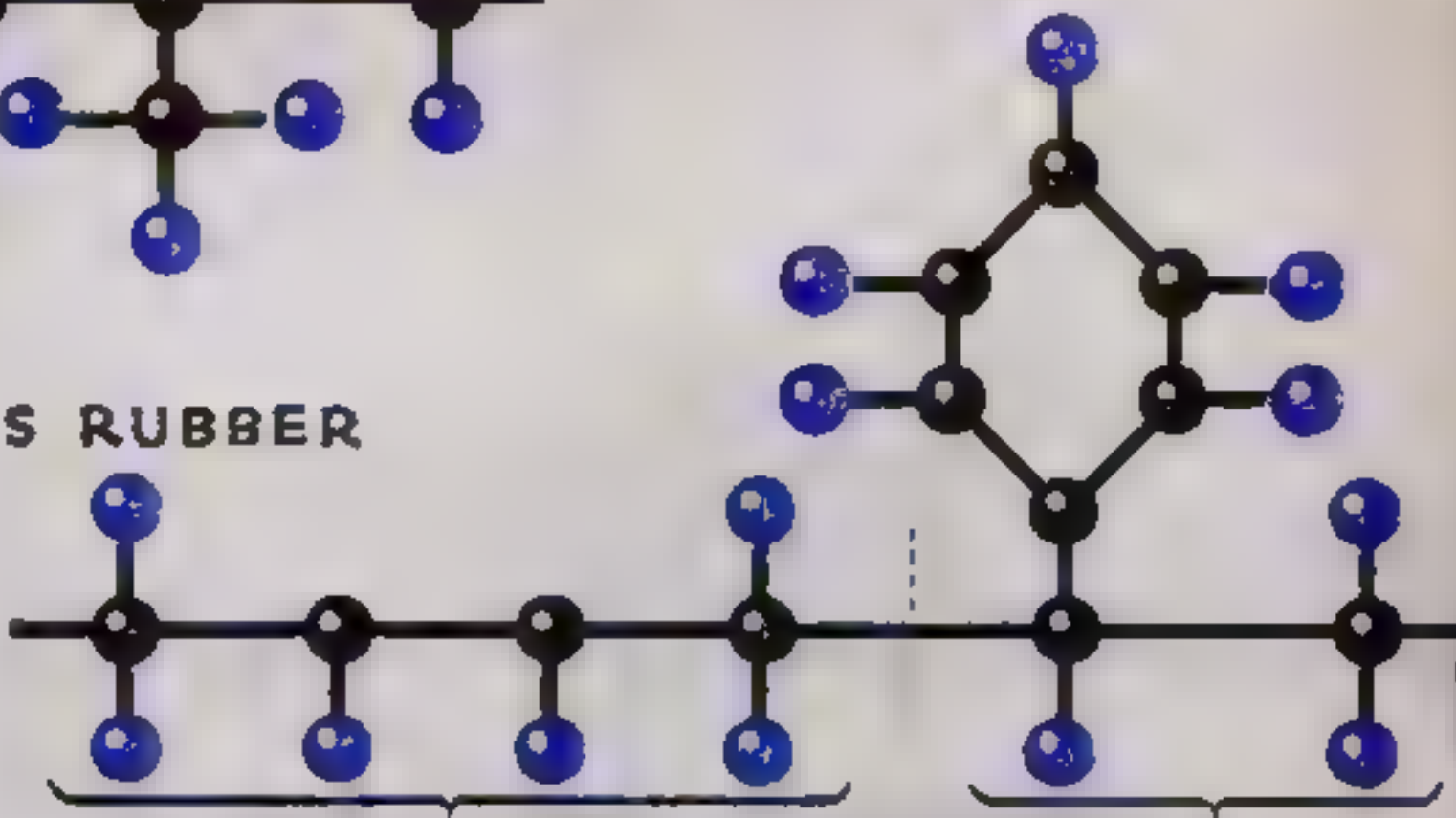
HYDROGEN ATOM

CARBON ATOM



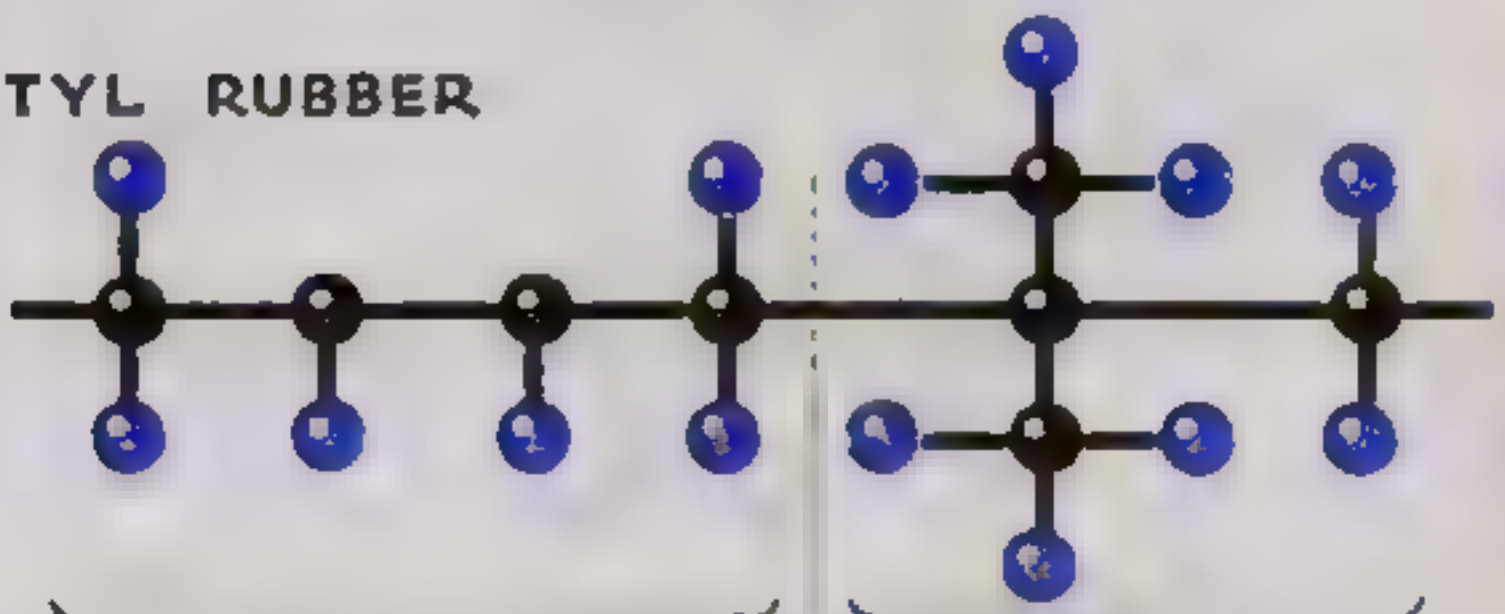
ISOPRENE MOLECULE

BUNA S RUBBER



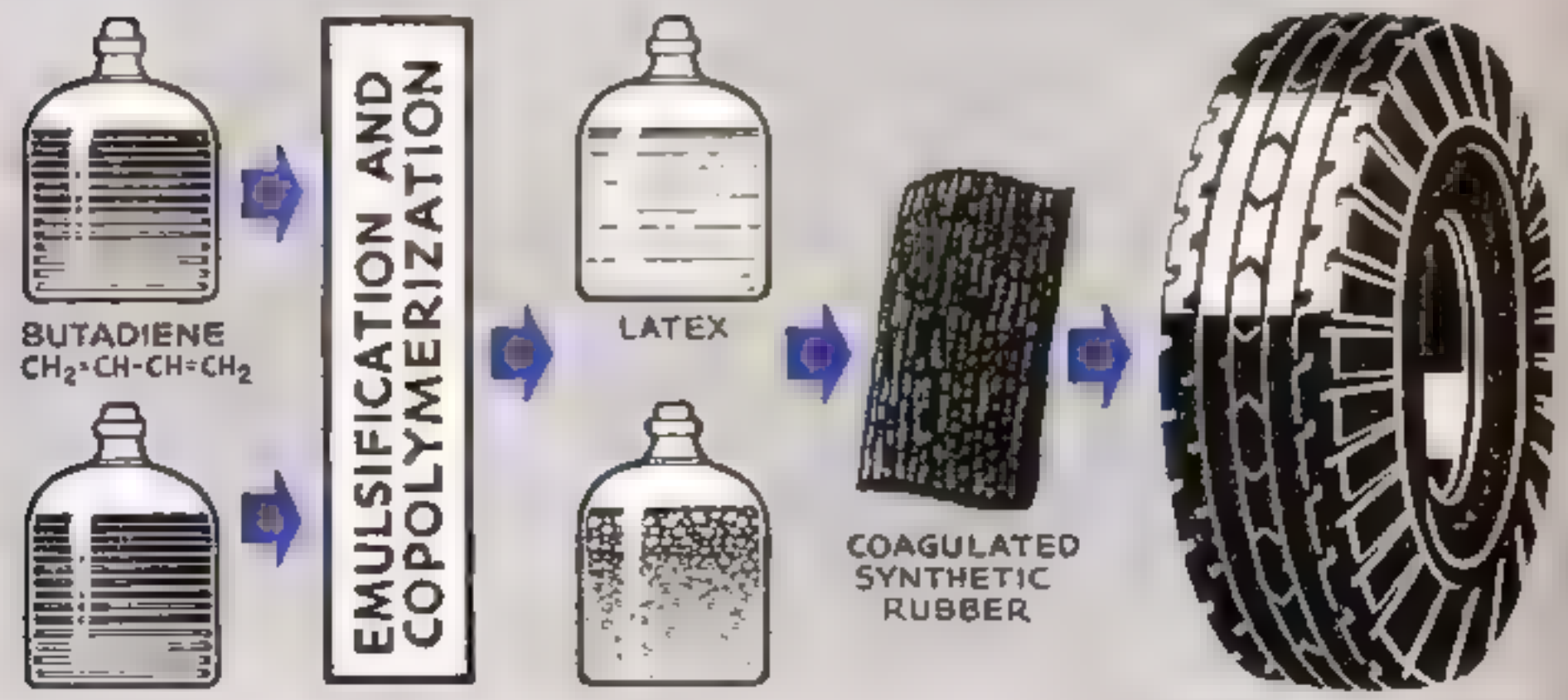
BUTADIENE + STYRENE + POLYMERIZATION = BUNA S

BUTYL RUBBER



BUTADIENE + ISOBUTYLENE + POLYMERIZATION = BUTYL RUBBER

BUNA SYNTHETIC RUBBER



dipping, or coagulated like a natural latex by the use of acetic acid. It may then be washed, dried, and worked like natural rubber.

At first, when one batch was finished it was taken out and another started. This method has largely been replaced by continuous processing which affords better chemical control and uniformity of product. And while the plant investment required is greater, the labor cost is lower.

The chemical makeup of Buna S, which is in the forefront of the projected American program, is a polymer of butadiene and styrene. Another type which promises to become important is butyl rubber, on which the Standard Oil Company of New Jersey owns the patents. This is a polymer of butadiene and isobutylene. The advantage of butyl rubber is that the required plant investment and total cost per pound appear to be markedly lower, although buna rubber is conceded to be somewhat superior in quality. The isobutylene which constitutes the principal ingredient in butyl rubber costs only about one eighth as much as butadiene, the principal ingredient of buna rubber. According to testimony before the Truman Committee, the cost of butyl rubber will be between 7 and 15 cents per pound; less than the cost of natural rubber and only about half the cost of buna. The investment required for butyl is about $700 per ton per year as against $1,000 for the same amount of buna. The buna process and the butyl process together head up our synthetic-rubber program as currently planned, with the former predominating by over ten to one in tonnage. Why, in view of the difference in estimated cost, which presumably reflects men-and-materials cost, more butyl production is not provided for is not quite clear at this writing.

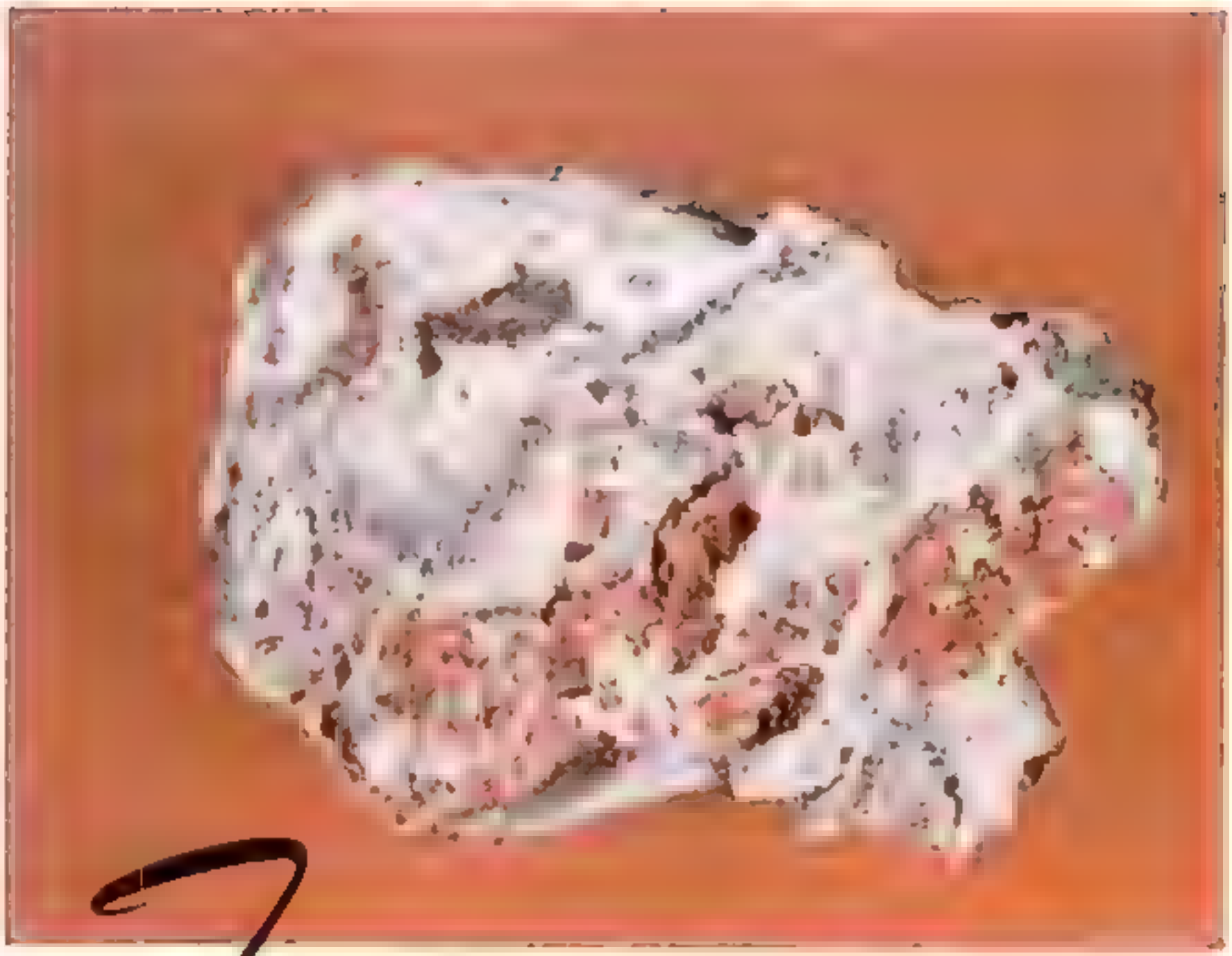
Tough rubber thread made synthetically to replace war-lost supplies. It is used for parachute harness, gas masks, and other equipment

Actually the synthetics we have been manufacturing were never intended to compete with natural rubber. Of the 30 known commercial types, all are more or less specialized products, neither intended nor able to compete with plantation rubber under pre-war conditions. The pioneer of American synthetics is Neoprene, a Du Pont product which originated in the research work of Julius Nieuwland, professor of chemistry at Notre Dame University. A number of other American synthetics—Ameripol, Koroseal, Hycar, Chemigum, Thiokol, etc.—have proved extremely valuable in industry. Experience with these synthetics has given American technicians some of the know-how which is expected to enable them to produce 700,000 tons a year by the end of 1943.

This is a colossal project—and I am not using the adjective the way they use it in Hollywood. If we are to produce 45,000 tanks in 1942, we shall need 45,000 tons of rubber; for 75,000 tanks in 1943, 75,000 tons of rubber. A total of 185,000 planes calls for 92,500 tons of rubber—half a ton per plane. Shipping calls for another 220,000 tons. These figures add up to almost 400,000 tons in two years, and that does not include trucks, scout cars and troop carriers, gas masks, barrage balloons, pneumatic rafts, gun carriages, ponton bridges, and the like. For direct military needs alone we must figure on getting 300,000 or 400,000 tons a year. And this takes no account of civilian needs.

American technology has solved tougher problems. This one falls into two main divisions—getting the raw materials, and processing them. The latter is remarkable chiefly in the amount of product required. Getting the raw materials is the bigger problem. It has been estimated that the equipment to recover the butadiene and other primary materials will cost three times as much as the polymerization plants.

Butadiene, which the petroleum industry will have to furnish in hefty quantities for making synthetic rubber, is normally a gas, but under compression can be transported as a liquid. It is derived mainly from another gas, butane. The latter is obtained from natural gas and cracked refinery gases. It is estimated that up to half of the available butane has been wasted in business-as-usual operation. Since butane has become precious one of the best sources for new supplies would seem to lie in modernization and improvements in the absorption plants that now remove gaso- *(Continued on page 204)*



Fighting Metal

MERCURY HELPS FIRE GUNS, EXPLODE BOMBS, AND KEEP THE WHEELS OF WAR INDUSTRIES TURNING

By ALDEN P. ARMAGNAC

MERCURY, known in peacetime principally as the silvery liquid in thermometers, has gone to war. It now sets off projectiles, speeds warships, and provides the right kind of electricity for making strategic materials. Among more familiar uses, it predicts the weather, sterilizes a cut finger, turns your oil burner on and off, and helps your dentist fill an aching tooth.

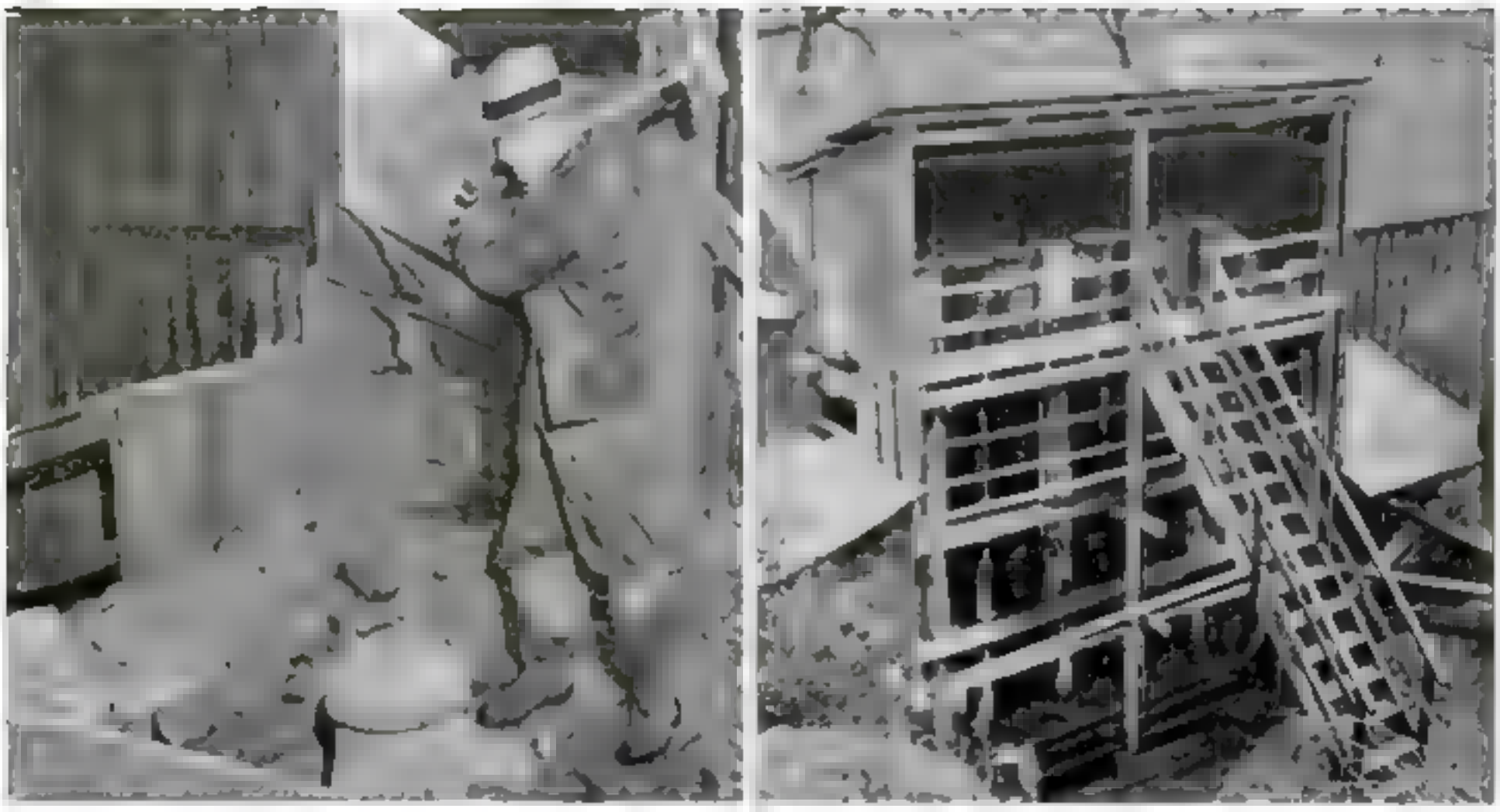
How many know where mercury is found, and why it best fits such varied uses? It would be a pleasant dream, for instance, if quicksilver could be pumped from wells. Miners have actually encountered native, or liquid, mercury—but in such small quantities as to be no more than a geological curiosity.

So all the world's mercury comes from a compound of the metal with sulphur, called cinnabar. Spangles of the red mineral, like jewels in a setting of gray rock, may be seen in the handsome specimen pictured above.

Ideally simple to smelt, cinnabar-bearing ore gives off mercury vapor and sulphurous fumes when it is roasted. Some of the big modern plants employ an inclined, rotary furnace resembling a cement kiln; in others, ore feeds downward through zigzag flues of a vertical furnace.

To recover the metal, fumes from the

CINNABAR provides practically all the world's supply of mercury. It is seen as scarlet flecks in a lump of ore in the photograph above by Charles Coles, American Museum of Natural History



Producing mercury at a California mine. At the left, chunks of ore are being broken up for the crusher. The bank of condenser tubes at the right recovers the mercury from furnace fumes. California leads the U.S. sources. Mexican mines augment the supply, and a recently discovered deposit in Canada helps

furnace are led through tall, air-cooled condenser tubes, where the mercury vapor turns to liquid quicksilver and trickles to receivers at the bottom. It goes to market in cast-iron "flasks" or cylinders containing 76 pounds apiece. At current boom prices, a flaskful sells for about $200, equivalent to nearly $75 a quart! No wonder that increasing numbers of midget mines are augmenting the stepped-up production of the big fellows. Surface and underground deposits in California, Oregon, and Nevada supply the bulk of this country's mercury.

Enough quicksilver to fill three railway tank cars, about 44,000 flasks, gives the United States third place among the nations of the world in yearly output. Spain and Italy run neck-and-neck for first and second rank, with something like 70,000 flasks apiece. Mexico helps balance the score for the United Nations. Recent discovery and exploitation of a rich deposit in Canada relieves the former total lack of mercury in the British Empire. With moderate restrictions, including a present ban on using mercury in making household thermometers, we should have all that we need for war.

What do we do with our 44,000 flaskfuls? More than half of them go into "mercurials," the many compounds of mercury with other chemicals.

Whenever a rifle is fired, a primer of fulminate of mercury ignites the powder charge of the cartridge. In shells and bombs, the same innocent-looking gray substance explodes upon impact, detonating a booster charge and the main charge in turn. Its use may be expected to increase, despite newly developed substitutes, under our vast ammunition program.

Anti-fouling paint for ship bottoms, a red composition containing mercury, prevents marine growth that would slow down speedy vessels. As the shadow of war approached us, early in 1941, U. S. Navy orders for the paint temporarily doubled the nation's consumption of mercury.

Two of the most widely used antiseptics, mercurochrome and bichloride of mercury, are derived from quicksilver. So is another medicinal preparation, calomel. Vermilion, or artificial cinnabar, imparts its brilliant color to rubber products, ceramics, and cosmetics.

A pivoted glass tube containing pure mercury and a pair of contacts makes an efficient electric switch for controlling automatic appliances such as oil burners. On a larger scale, devices containing vaporized mercury turn familiar alternating current into direct current to produce critically needed magnesium and aluminum, as well as to operate electric locomotives, subway

SMELTING AND MARKETING. *Roasted in a revolving furnace, cinnabar decomposes into vapors of mercury and sulphur dioxide. Mercury is condensed, bottled in iron flasks*

CONDENSERS

HOT MERCURY VAPOR COOLS TO LIQUID METAL IN CONDENSERS AND IS COLLECTED AT BOTTOM

CARS FROM CRUSHER DUMP ORE INTO HOPPER

CHARGING HOPPER

STACK EXHAUSTS REMAINING FUMES

DUST COLLECTOR

FAN

MOTOR AND GEARS ROTATE FURNACE

MERCURY RECEIVER

VAPORS ASCEND THROUGH FURNACE

ORE TRAVELS DOWNWARD THROUGH FURNACE

HEAT DECOMPOSES MERCURY-BEARING CINNABAR INTO MERCURY VAPOR AND OTHER FUMES

SCREW PLUG

CAST-IRON FLASK HOLDS 76 LBS OF MERCURY

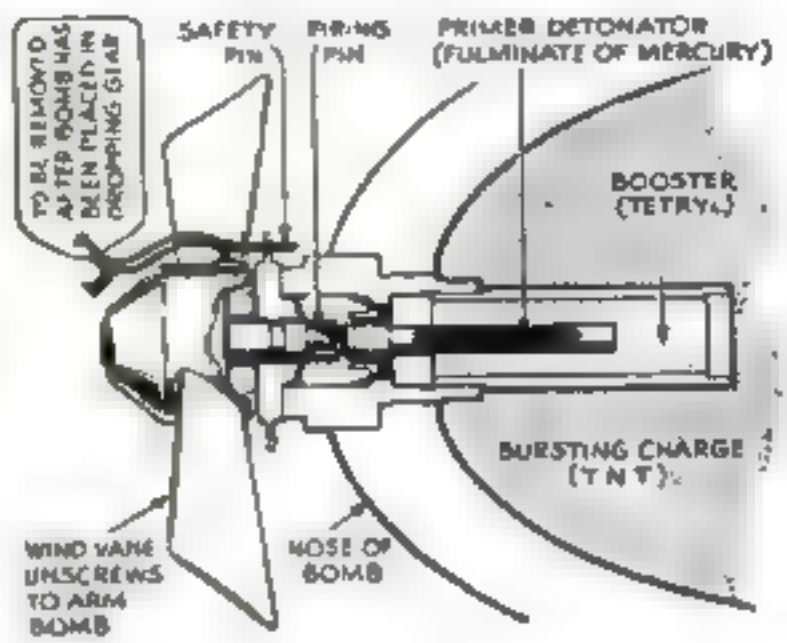
TREATED ROCK GOES TO BIN FOR DISPOSAL

Steel tubing condenses mercury va
from ores at the Cordero Mine in

How Mercury is Bottled

With dipper and funnel, a standard flask is filled with 76 pounds of mercury for marketing. This amount equals about 2¼ quarts and is worth $200 at the prices prevailing today

Fulminate of mercury sets off the explosive charges in cartridges, bombs, and shells. In the drawing below, you can see how this innocent-looking powder serves an aerial bomb



rs, and machinery in steel mills and printg plants. Fluorescent lamps also employ ercury vapor.

Barometers and manometers can indicate ressure on compact scales because of the reat density of liquid mercury, 13½ times ut of water. It expands so evenly through wide temperature range that t has no substitute in high-recision medical and laboraory thermometers.

Mixtures of mercury with owdered silver or gold quick- form the solid amalgams, alloys, used by dentists for filling teeth. Likewise, the affinity of mercury for gold finds use in mining the precious metal. When the pulverized ore is washed over mercury-coated plates of copper, the gold amalgamates with the mercury. Then the amalgam is scraped off and distilled, removing the mercury and leaving the gold.

Mercury-vapor turbines now supplement steam turbines, for improved efficiency, in a few pioneering U. S. power stations. A big one at Kearny, N. J., circulates 20 tons of mercury. War's end will release huge amounts for similar use.

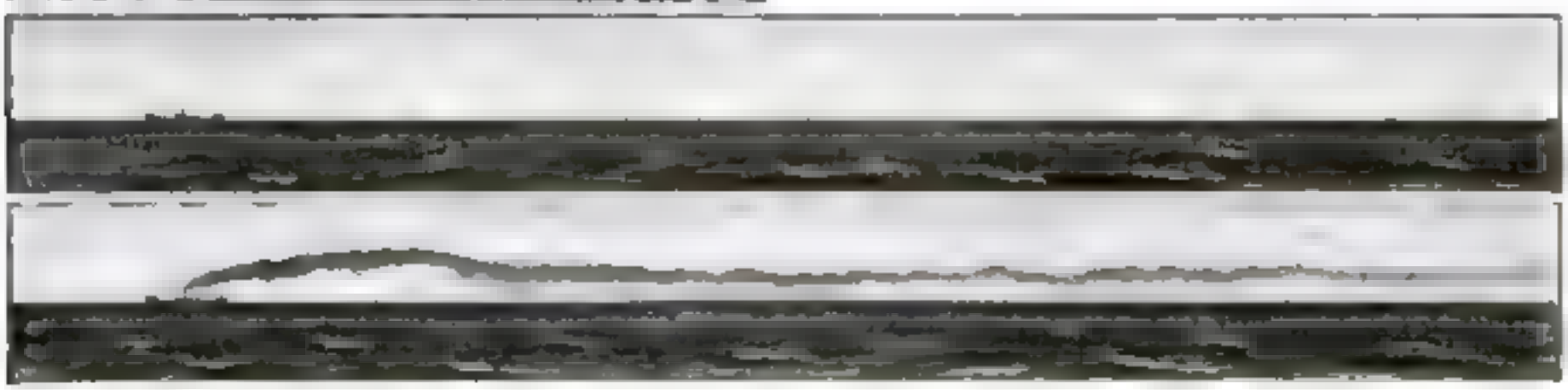
EXTREMES IN MERCURY MINES —FROM OREGON TO MEXICO

Extracting plants range from crudest to most elaborate. In these pictures from the U.S. Bureau of Mines, compare the modern Oregon installation above with the primitive outfit at the left, in the Conoas district of Mexico. Both can sell all the mercury they produce

Periscope Tells Tanker Fireman of Telltale Funnel Smoke

PEERING into a periscope eyepiece in the boiler room, firemen aboard oil tankers now can see at all times whether smoke is coming from the stacks of their ships. Since enemy submarines easily locate ships by their smoke trails, firemen guard against fueling their fireboxes so that incomplete combustion sends clouds of telltale soot aloft. Thus when a ship is hull down, only its superstructure is visible to enemy craft. If it is completely below the horizon there is no trace of the vessel. The periscope device is pictured at left close beside the fireman's fuel-control valves. Drawings show the great difference that smoke makes in the visibility of a vessel at sea.

Left, a tanker fireman at his fuel valves watches in the periscope for any smoke coming from the funnels to betray his ship's position to lurking submarines



U-boat commanders look long and often in vain to spot a small ship on the sea horizon, as you can appreciate from the upper sketch. But a smoke trail, avoided with the funnel viewer, gives the vessel away

Movie Camera in Fighter's Wing Records Aerial Battles

IF YOU have wondered how they make the newsreel movies that show enemy planes disintegrating in midair from the bullets and shells of Allied war planes, the explanation appears in the picture at the right. The plane is a four-cannon British Hurricane fighter. Beside one of the cannons in the leading edge of the wing is a movie camera that turns the trick. Operating whenever the guns fire, it photographs everything dead ahead of the guns. During flight of the ship, the camera cover is closed except for a small aperture in front of the lens. The films corroborate pilots' reports of damage done, and help train new air fighters.

Smashing enemy tanks is one of the many important jobs that "Little Poison" is doing wherever our troops

WHEN the fighting men and the gun-loving technicians finally get around to talking things over, and the legends and stories of the Second World War get themselves written down, will there be some one weapon they'll remember and talk of as the special, characteristic gun of this war?

It's a pretty safe bet there will be, for an affectionate interest in the tools of the trade has been a soldierly trait for as long as men have been marching out to war.

And when we settle on the "big" gun of this war, it may well turn out to be a relatively small one—the handy, hard-hitting, ever-present 37-millimeter gun, fondly known to the present generation of American troops as "Little Poison."

It is far and away the most versatile of all weapons above the small-arms class. The 37 has gone to this war on the land, on the sea, and in the air, and there can have been no engagement of major significance since Sept. 1, 1939, in which it has not been present, playing an important and sometimes a decisive role.

Tanks and planes have forced the fighting on most fronts, and at one time or another, in its various models, the 37 has been best friend or worst enemy to both. It is the lightest of field guns and the heaviest aircraft cannon yet used in a standard fighter plane.

The 37 is not a brand-new weapon. American troops used a 37-mm. field gun in the First World War, although it was a rather primitive tool compared to the highly developed guns of today. That gun was the Model 1916, more commonly known as a one-pounder because it fired high or low-explosive shells weighing a little more than a pound. It was used mainly against machine-gun nests or isolated strong points where heavier artillery or mortars were tactically unsuitable.

The 37 really came into its own in Europe in the decade after the war, when thoughtful military scientists realized that tanks and armored vehicles were destined to lead

Little Poison

That's What Our Men Call the Army's 37-mm. Gun — Versatile, Hard-Hitting, Pint-Size Giant That Is in on Every Scrap

• • •

are in contact with the enemy on any front of war

By J. H. WALKER

the ground attacks of any future war. Theories of defensive warfare were popular, with heavy emphasis on fixed fortifications and the development of speed and volume in fire power.

It became clear, however, that a well-equipped army would need a new type of light field gun to deal with the tank or armored assault car. Military trends indicated that this gun should be something of a compromise, with more hitting power than the heavy machine gun, but more maneuverability and a higher rate of fire than the existing light-artillery guns of the French 75 class.

Various nations experimented with light guns in calibers ranging from 25 to 50 mm. Germany, Russia, and the United States specialized in the 37. Both the Russian and American antitank guns, incidentally, are modifications of a basic design worked out by the German Rheinmetall company in the early 1930's.

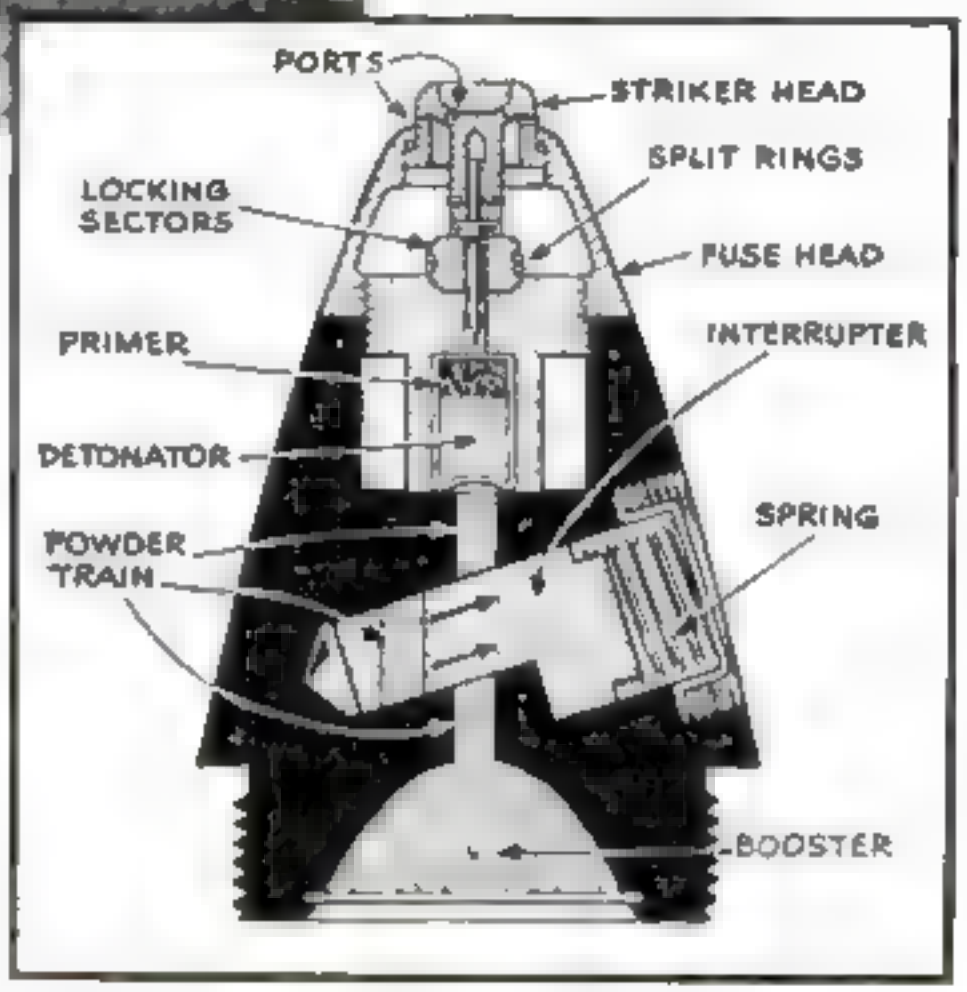
Once the new-type 37 had been proved successful, it was speedily adapted for special military purposes. Today, in the U. S. Army, the 37 is carrying out four main jobs

1. *Antitank gun*—in reality a light field gun, although we classify it as an infantry weapon. (The cavalry and armored force also use it.) It is mounted on rubber tires for speedy towing, usually by a half-ton truck. The entire gun and carriage weighs only 912 pounds. It is a single-shot weapon, firing projectiles of about two pounds.

2. *Medium antiaircraft gun*—particularly adapted for use against dive bombers. This is an automatic weapon, feeding shells in clips of ten and capable of firing at the rate of 120 shots a minute. A burst of 50 shots is usually considered the maximum for sustained fire, however, because of overheating. The gun itself weighs only 365 pounds, but is equipped with a 2.5-ton carriage of special design, with rubber-tired wheels which enable the assembly to be towed along the highway at 60 miles an hour. The wheels retract so that the chassis can rest solidly on the ground when the gun is going into action. [CONTINUED]

As an antiaircraft gun (above) the 37 uses a special tracer shell with a supersensitive nose fuse shown at the right. This shell explodes at the slightest contact with a plane

Here are the four main uses to which the 37 has been adapted by the U. S. Army: antiaircraft antitank, tank gun, and hard-hitting weapon for warplanes



3. *Tank cannon*—a somewhat trimmed-down version of the antitank gun. In normal action two men operate the gun, which forms part of the armament of most U. S. tanks.

4. *Airplane cannon*—in some respects the least known of the 37-mm. family. This is a fully automatic gun, a true machine cannon, controlled from the pilot's cockpit by a cable connection. Ammunition, which must be loaded on the ground, is carried in an endless belt, and empty shells are dropped from the plane immediately after firing. This cannon has a rate of fire of 120 rounds a minute, but in actual practice, no such amount of ammunition is carried. Space and weight are precious in a high-speed fighter plane. A skilled pilot can nurse this supply along, firing in short bursts, and the hitting power is so great that a very few rounds in the right place will do the business with any hostile plane.

All these models of the 37 share the virtues of relative compactness, light weight, high rate of fire and high muzzle velocity—which is the measure of the gun's punching power. All have certain features of design in common, notably the hydraulic recoil mechanism. And they all have one more thing in common, too—they all speak out with a sharp, authoritative bark, and plaster their targets with shells almost exactly as big around as an old-fashioned U. S. silver dollar.

The basic model 37, of course, and the one that will be most familiar to soldiers and civilians alike when this war is over, is the antitank gun, M-3, the original "Little Poison." That is the trim, long-barreled, rubber-tired piece, looking like a streamlined, stylishly slender model of a First World War field gun. Each of our new "triangular" infantry division has 60 of them. (U. S. armored divisions lump their tank and antitank guns together, making a total of 411 of the 37's in each division.)

This gun can be rolling along a highway at 30 miles an hour behind its prime mover, and when the commander sights a target and orders action, a properly trained crew will stop, uncouple the gun, aim it, and be ready to open fire in from 26 to 32 seconds.

More often, in combat, the gun would be in cover position ahead of time, with an action position prepared near-by. Thus the gun and its crew can remain hidden until the moment of opening fire, when their position would have to be revealed to the enemy in any case. When action is ordered the

gun is moved forward by hand and opens fire at once.

You can get a rough idea of the speed and flat trajectory of the gun's projectiles by the fact that a 37 can bust up a target 1,000 yards away with a slug of steel that never goes over six feet above the ground all the way. The 37 does most of its work at ranges of 1,000 yards or less—often very much less, indeed.

The normal crew includes six men—a corporal commanding, truck chauffeur, gunner, assistant gunner, and two ammunition carriers. But AT guns inevitably draw plenty of fire in a hot engagement, and the weapon is designed to be handled and fired right down to the last man. The Army's Basic Field Manual is calm, but very explicit, on that point:

"In a crisis, fire once opened must be continued, as one soldier can operate the gun. *The squad is trained not to withdraw under hostile fire during a tank attack.*"

The muzzle velocity of the shells fired runs around 2,700 feet per second. Air resistance cuts this down to about 2,100 feet per second at 1,000 yards, a statistical fact which must be of remarkably little consolation to whatever is in the way at that point.

The ammunition for the 37 family is as varied as the guns themselves. Basic types are the high-explosive and the armor-piercing shells; the Army has found that a shell exploding against a tank's armor doesn't do as much permanent damage as a solid, two-pound chunk of steel boring through the armor wall and then ricocheting around inside like a lethal billiard ball.

The airplane and antiaircraft cannons both use a special tracer ammunition with an ultrasensitive nose fuse, which explodes violently at the lightest contact with a plane's wing, body, or tail surfaces. The shells also have a self-destroying property; if they don't hit anything, the fuse explodes them anyway to avoid doing damage on the ground.

But the newest wrinkle in 37-mm. ammunition is made especially for the gun mounted in tanks, and it turns out to be a very old wrinkle. The Army has revived canister shot, which dates all the way back to the fifteenth century, and has modernized it for the tank gun

This 1942-model canister shot is an iron-and-tin can, crimped into a standard shell case. Inside the can are 123 ⅝-inch steel balls. About 30 yards out from the muzzle the can disintegrates and the burst of steel shot rakes an area 20 yards wide and up to 200 yards long. The tank uses this kind of shell against personnel at short ranges—that is to say, enemy troops who are resisting capture or attempting to surround and damage the tank

All things considered, it becomes pretty clear that although the 37 may have been worked out originally for defensive purposes, the U. S. Army seems to be sparing no effort to use it as a weapon of oportunity and offense. This is especially clear in the experiments that have been carried on for the past year, using 37's mounted on jeeps, balloon-tired "swamp buggies," or fast three-quarter-ton trucks.

Guns mounted that way don't wait for enemy tanks to come and fight— they go looking for them. Of course, one thing should be remembered: the traditional rule of thumb that a projectile will pierce its own caliber in armor plate. If tank armor is increased in thickness, heavier guns may have to shoulder some of the 37's assignments.

In the air, however, the 37 plane cannon ranks as a heavyweight champion. We mount it in the nose of the P-39 (Bell Airacobra) fighter plane. The Russians also like the gun, and are reported to have developed a pneumatic recoil for air cannon, with a column of air, instead of heavy oil, taking up the firing shock.

The Germans, the Japs, and (up to now) the British, have generally preferred 20-mm. airplane cannons, claiming they weigh less and can carry more ammunition on a flight. That may be, but the function of a gun is to hit. And when you match the two up alongside each other, you find the 37-mm. bore is still the size of a silver dollar—and the 20 is just the size of a nickel. [*CONTINUED*]

1 "Little Poison" goes into action. Drawn by its prime mover, the gun arrives at the chosen firing position

2 As the truck stops, crew members hit the ground. Gunner and assistant gunner go over the tailboard, ammunition carriers over the sides and the squad leader leaves his seat by the driver

3 Ammunition bags are slung over the gun shield. Squad leader (at right) directs the ammunition carriers in uncoupling the gun

4 One on each side of the gun trails, the two carriers uncouple the gun. As the lunette comes free of the pintle, the nearer man calls "Forward" to the driver

SERVING THE 37-mm. ANTITANK GUN: PRECISION TEAMWORK KEEPS

The gunner at left below aims the gun, operating the traversing wheel with his right hand, the elevating knob with his left. The loader operates the breech mechanism with his right hand while his left takes ammunition from the carrier behind him. He keeps his body to one side to clear a path for ejected cartridge cases

5 While the truck pulls forward the men place the gun in the position indicated by the squad leader. A shallow emplacement may be dug for it

6 As the gunner and assistant (loader) prepare the gun for action, carriers spread the trails and plant the trail spades firmly into the ground

7 Wheel segments are lowered as below to take weight off the tires. This gives greater rigidity

8 Now the gun is ready for action, covering the crossroad seen in the distance. The whole operation has taken a maximum of 32 seconds. The towing truck takes cover until it is needed again

A STREAM OF SHELLS POUNDING THE ENEMY

At the rear, the second carrier removes ammunition from bags like that shown at the far left, cleaning each shell before passing it forward. While each man has his special job to do, all are trained to double when casualties occur. In a pinch, one man can keep the gun in action. The Manual says: "Fire once opened must be continued

Close-ups show loading (above) and aiming. Gunner is trained to elevate, traverse, and fire simultaneously at high speed

Here's My Story

JEROME C. HUNSAKER, NOTED AERONAUTICAL DESIGNER AND RECENT WINNER OF THE FRANKLIN INSTITUTE MEDAL, WAS BORN AT CRESTON, IOWA, IN 1886

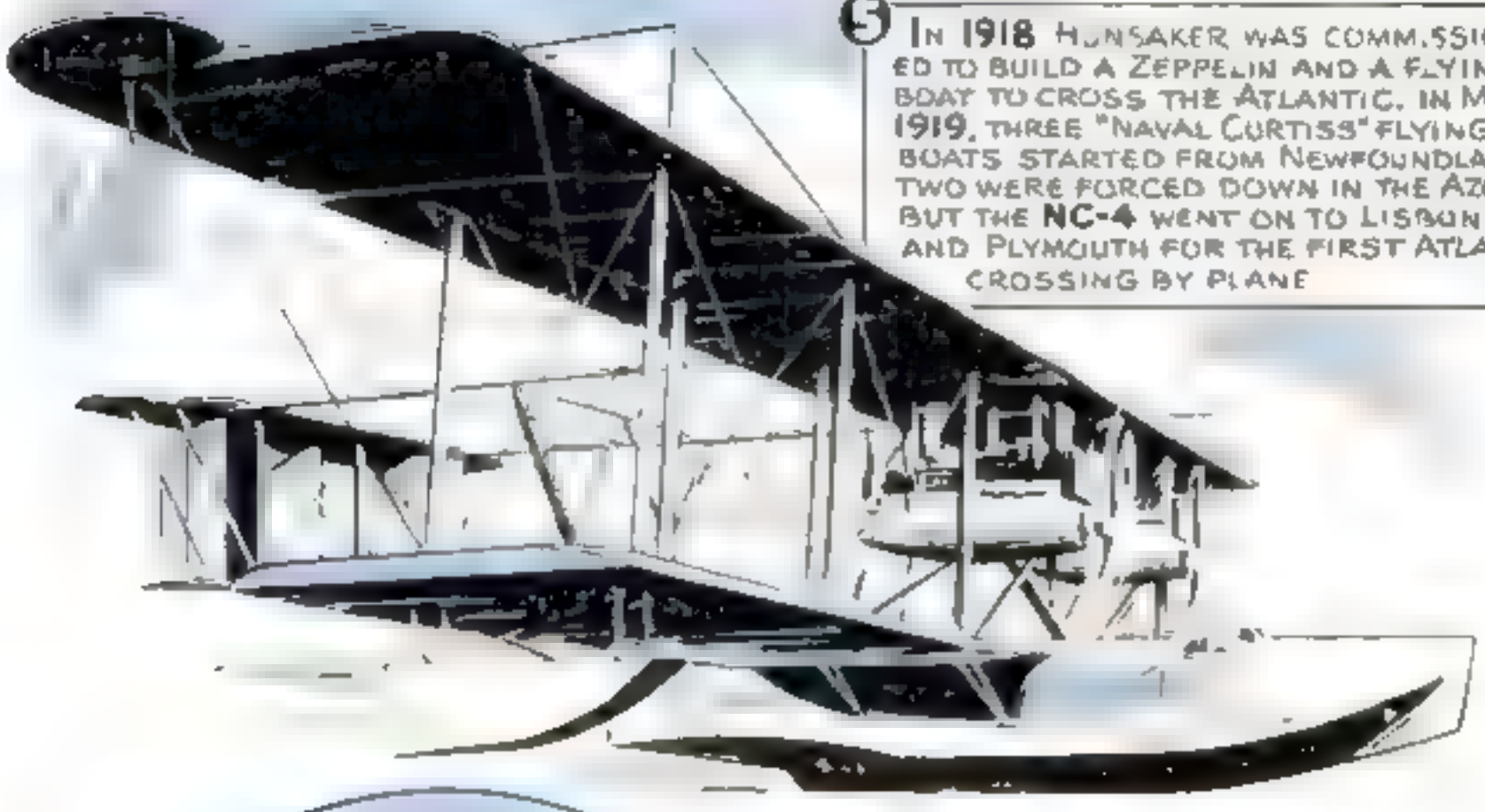
1 YOUNG HUNSAKER WAS EDUCATED IN PUBLIC SCHOOLS AT DETROIT AND SAGINAW, MICH AS A YOUTH HE WAS A SKILLED TAXIDERMIST AND BECAME INTERESTED IN BIRD FLIGHT

2 AFTER HIGH SCHOOL HE ENTERED THE U.S. NAVAL ACADEMY AND GRADUATED AT THE HEAD OF HIS CLASS IN 1908. HE SPENT THE NEXT YEAR ABOARD THE U.S.S CALIFORNIA

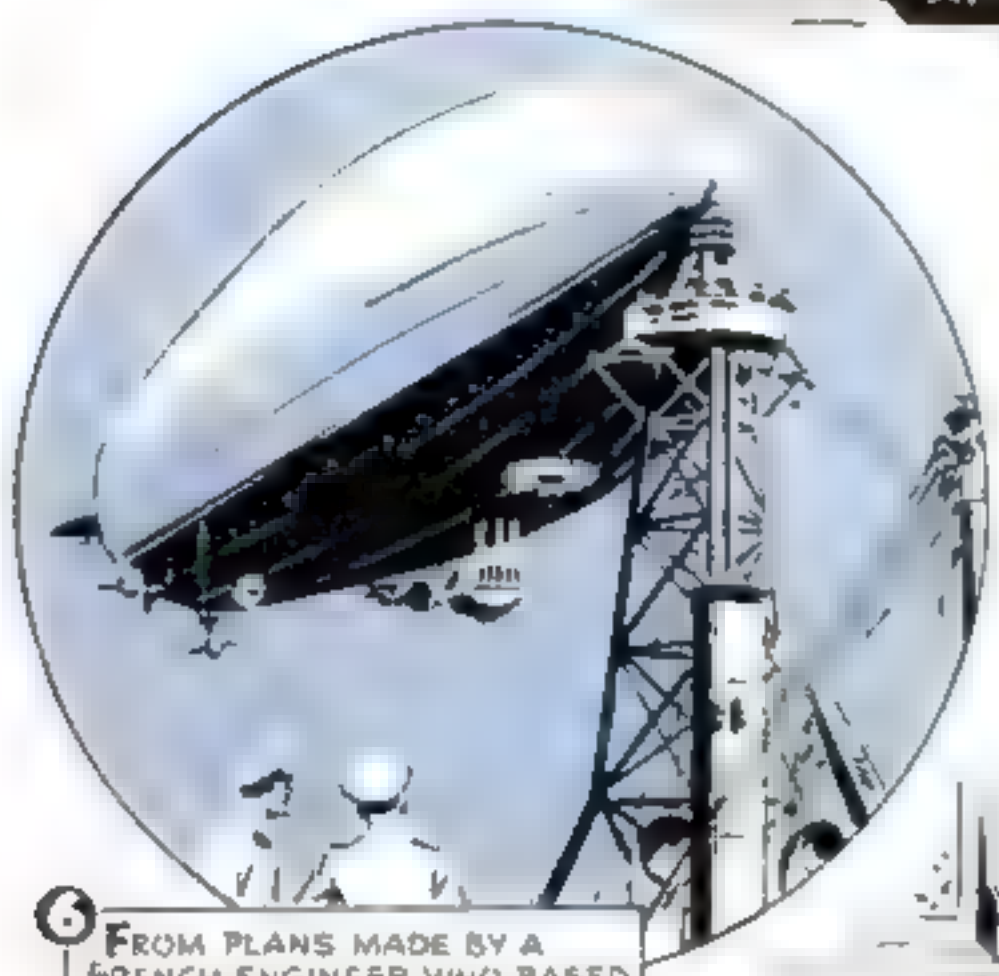
3 IN 1909 HE WAS TRANSFERRED TO THE NAVY'S CONSTRUCTION CORPS AND WAS SENT TO M.I.T. FOR TECHNICAL TRAINING. AIDED BY HIS WIFE, HUNSAKER TRANSLATED EIFFEL'S WRITINGS ON THE WIND TUNNEL AND RECEIVED AN INVITATION TO VISIT THE FRENCH ENGINEER IN PARIS

4 HE WORKED WITH EIFFEL'S ASSISTANTS IN 1913 TESTING MODEL PLANES IN WIND TUNNELS BEFORE RETURNING TO THE UNITED STATES, HUNSAKER VISITED GERMANY AND MADE A CRUISE IN A ZEPPELIN. HE ALMOST LOST HIS WELCOME BY TRYING TO EXAMINE DETAILS OF THE AIRSHIP'S CONSTRUCTION.

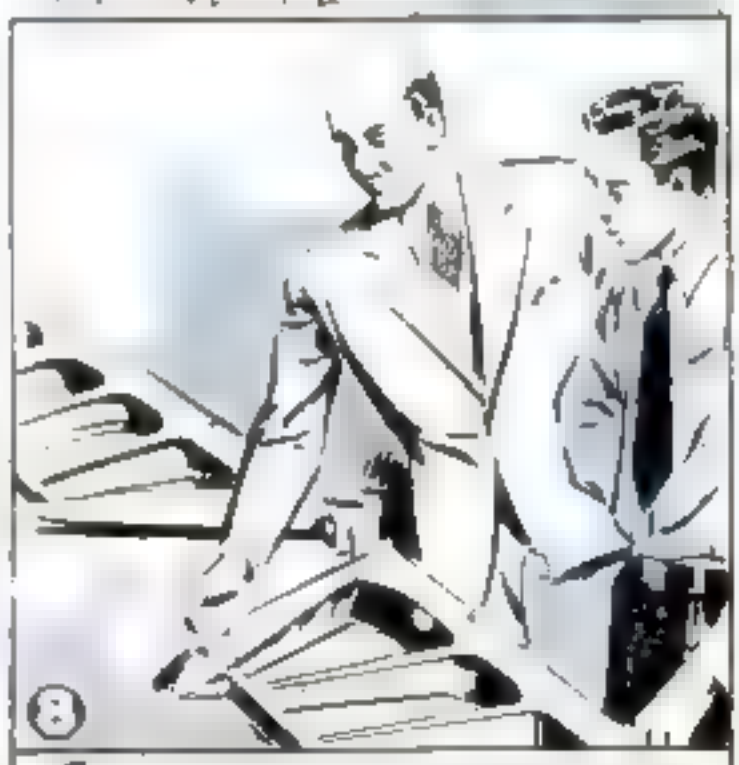
THE CAREER OF JEROME C. HUNSAKER



5 IN 1918 HUNSAKER WAS COMMISSIONED TO BUILD A ZEPPELIN AND A FLYING BOAT TO CROSS THE ATLANTIC. IN MAY, 1919, THREE "NAVAL CURTISS" FLYING BOATS STARTED FROM NEWFOUNDLAND. TWO WERE FORCED DOWN IN THE AZORES BUT THE **NC-4** WENT ON TO LISBON AND PLYMOUTH FOR THE FIRST ATLANTIC CROSSING BY PLANE



6 FROM PLANS MADE BY A FRENCH ENGINEER WHO BASED HIS DESIGN ON A CAPTURED GERMAN ZEPPELIN (**L-49**), HUNSAKER CREATED THE **680**-FOOT SHENANDOAH IN **1923**. THIS WAS THE FIRST ZEPPELIN-TYPE AIRCRAFT TO USE HELIUM AS A LIFTING GAS



7 AFTER SERVING AS ASSISTANT NAVAL ATTACHE ABROAD, HUNSAKER RESIGNED FROM THE NAVY IN **1926** WITH THE RANK OF COMMANDER. THE SAME YEAR HE WAS PUT IN CHARGE OF THE WIRE AND COMMUNICATION SERVICES FOR COMMERCIAL AVIATION AT BELL TELEPHONE COMPANY

8 STILL INTERESTED IN LIGHTER-THAN-AIR CRAFT, HE BECAME ASSOCIATED WITH THE GOODYEAR TIRE AND RUBBER COMPANY IN **1928** AFTER DESIGNING THE DIRIGIBLES AKRON AND MACON, HUNSAKER WENT BACK TO **M.I.T.** AS HEAD OF THE COMBINED DEPARTMENTS OF MECHANICAL AND AERONAUTICAL ENGINEERING

Tagged Atoms

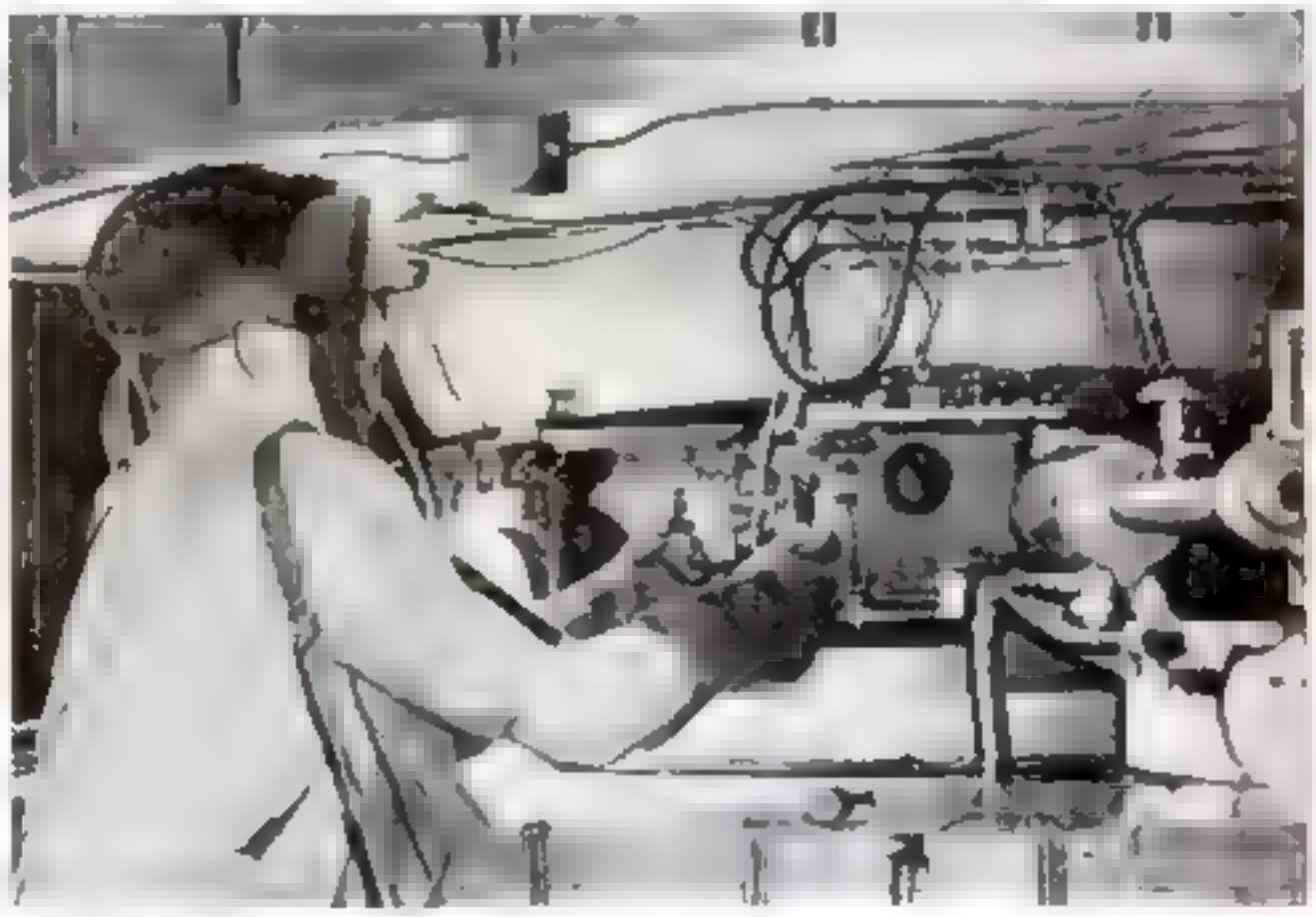
HELP SOLVE THE MYSTERIES OF LIFE

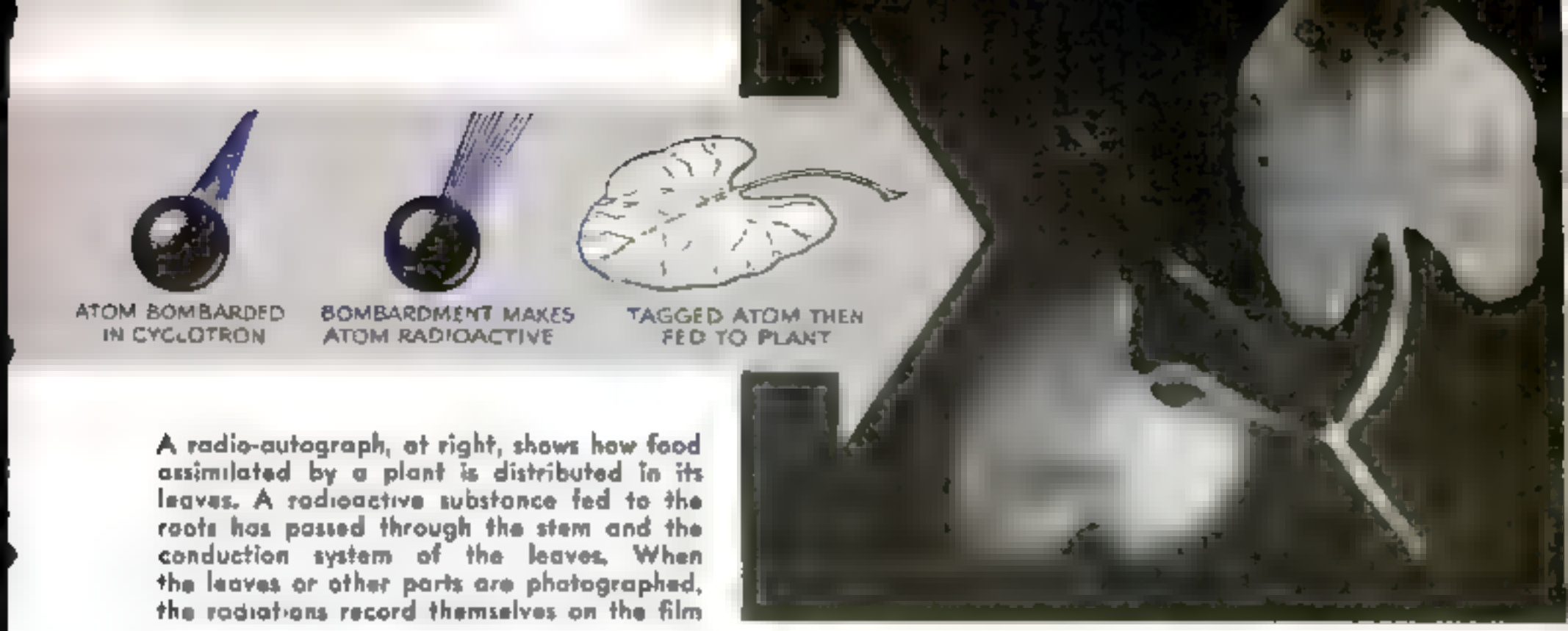
SCIENTISTS are using a new tool, dramatically called "tagged atoms," which is enabling them to penetrate deeper and deeper into the mysterious processes of life. With it they can study the metabolism of living organisms in structures as simple as bacteria and as complex as man. Speculation based on the old analytical chemical techniques soon will give way to exact knowledge. The biologist will *know* what happens to food and other substances when they are taken up by plants or absorbed by the human body.

Tagged atoms are the result of the discovery of artificial radioactivity, the development of the atom-smashing cyclotron, and the consequent preparation and identification of the radioactive isotopes of some 300 stable elements. Briefly, it is a series of techniques by which various substances, made radioactive by bombardment in the deuteron beam of the cyclotron, can be traced through the body or the structure of a plant by means of sensitive recording devices, or by photographing the actual course of the exploding atoms by the glow of their own emanations. It will be used on a large scale for the first time at a new medical-physics laboratory to be established this summer by the University of California.

Of the 300 identified isotopes, which are variants of as many elements but chemically indistinguishable from them, 21 have already been tagged with radioactivity and employed by research scientists as tracers

"Tagging" atoms for biological research: The material to be made radioactive is placed in a small aluminum envelope and pressed, as shown above, into a shallow groove in the face of a copper target plate where it is secured by an oval rim. The plate is bolted to a copper bell jar (left, below) which in turn is bolted to the cyclotron as seen at the right. Both sides of the bell jar are evacuated of air





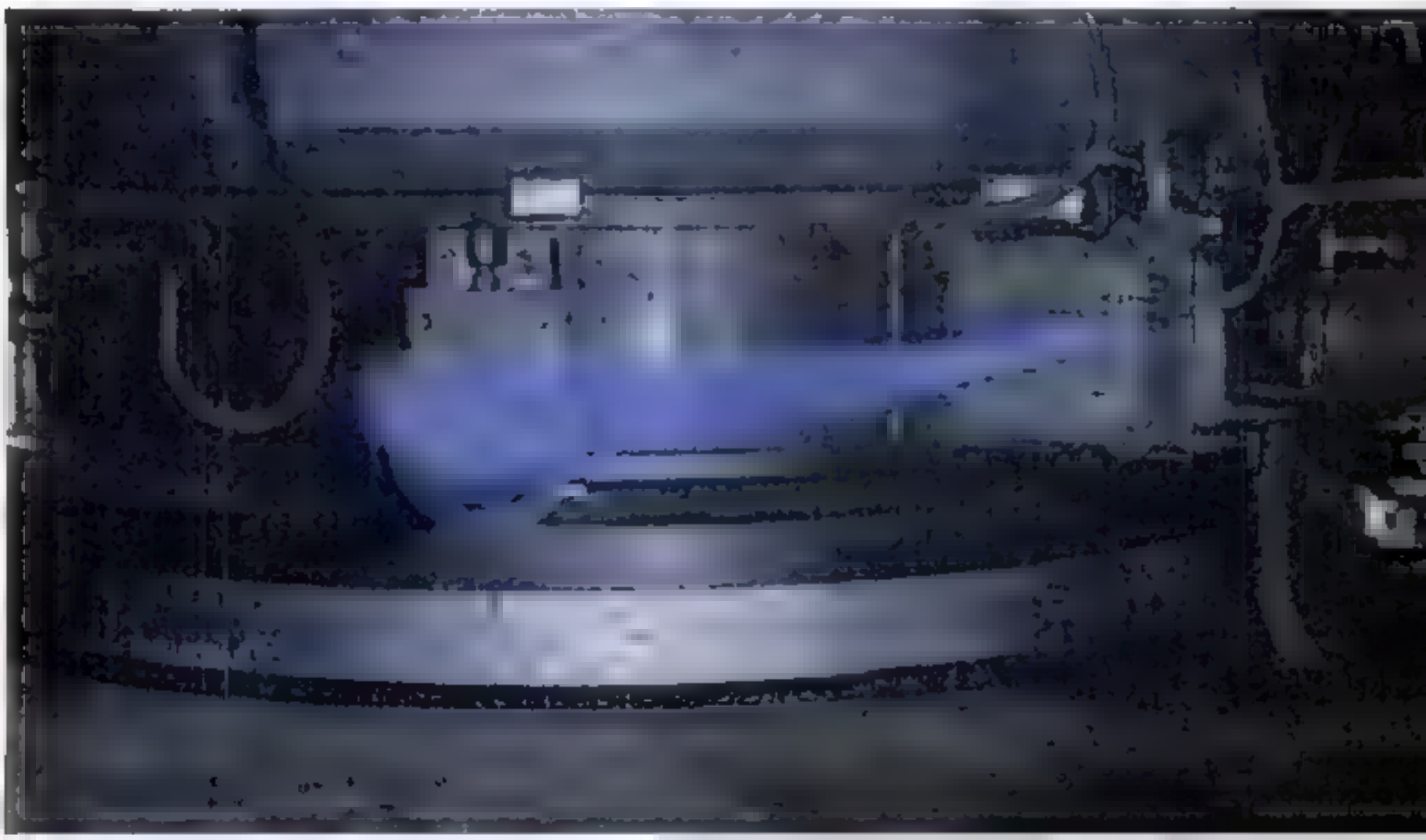
A radio-autograph, at right, shows how food assimilated by a plant is distributed in its leaves. A radioactive substance fed to the roots has passed through the stem and the conduction system of the leaves. When the leaves or other parts are photographed, the radiations record themselves on the film

for metabolic studies. Among them are sodium, zinc, phosphorus, iron, calcium and strontium, salt, carbon; potassium, which is being prepared for a military purpose that cannot be disclosed; and iodine, which is obtained by means of that ancient dream of the alchemist, transmutation—tellurium is bombarded in the cyclotron with the deuterons of heavy hydrogen particles, and is transmuted into radioactive iodine

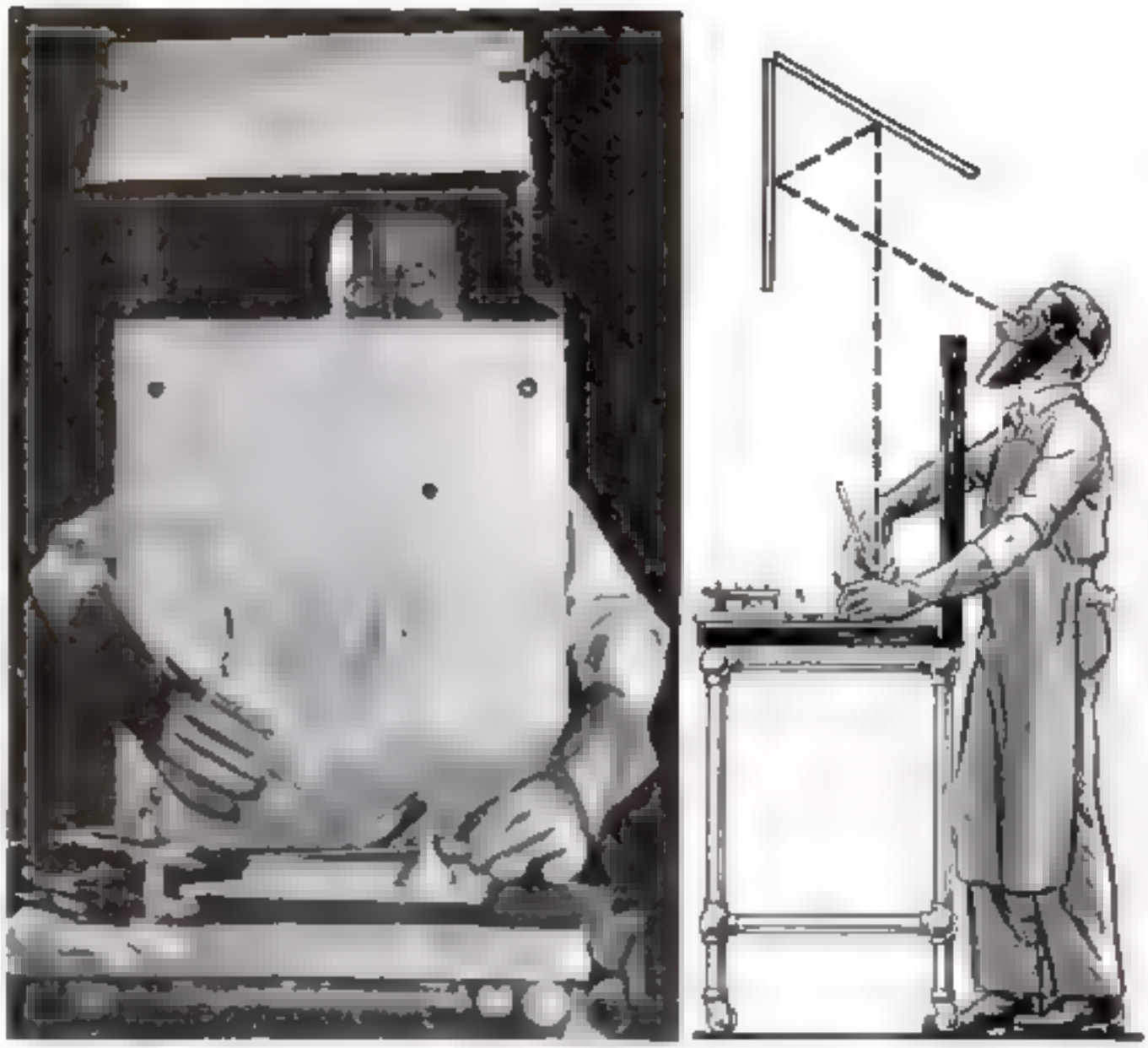
At Harvard University, where the cyclotron photographs illustrating this article were taken, the material to be activated is put into a small aluminum envelope and pressed into a shallow groove cut into the face of a copper target plate about six inches long and three inches wide. A rim to hold the envelope in place is screwed down, and the target plate is secured by four strong bolts to a copper bell jar. This in turn is bolted to the cyclotron, and both sides of the bell jar are pumped free of air to provide a partial vacuum. The cyclotron beam is confined to the bell jar, and so hits the target. Transmutation of the substance in the aluminum envelope begins when it is bombarded by the atomic particles or ions of the beam. Some of its atoms are transmuted to stable forms, and others to forms which are radioactive, acquiring properties similar to those of radium.

Substances which at present are being tagged by the cyclotron require varying periods of exposure to the beam. Sodium, for example, can be made radioactive in 45 minutes to one hour, while phosphorus must

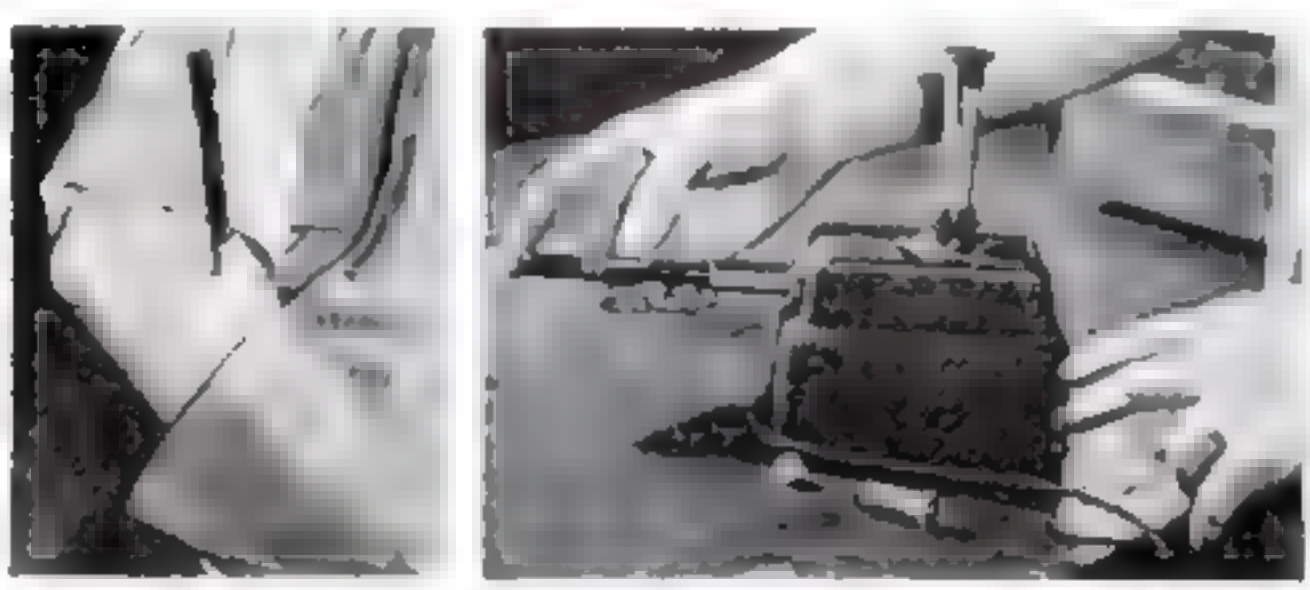
The cyclotron beam, composed of atomic particles traveling at terrifically high speed, transmutes some of the atoms of the bombarded material into forms which are radioactive. In actual operation, the beam would not be visible since it would be confined to the bell jar and target. These cyclotron photographs were taken at Harvard University and show the use of that institution's 42-inch instrument



be bombarded for ten to 20 hours. There is also a considerable variation in the half-life of these materials, the period in which one one half of the radioactivity will be lost through the explosion of the atoms. All these radioactive materials are exactly the same as their stable counterparts, and are employed by the body in chemical reactions like ordinary elements. But the radioactive atoms, being overcharged with energy, eventually explode, throwing off electrons and beta and gamma rays which shoot through plant and animal tissue like so many machine-gun bullets. These atomic projectiles are discharged in incredible numbers and travel at incredible speeds. The average dose of radioactive phosphorus will throw off 30,000,000 electrons every minute, and they will hurtle through the body at something like 45,000,000 miles an hour.



Screened by a thick shield of lead, the operator removes the radioactive material from the target plate. An arrangement of mirrors, illustrated at the right, enables him to see what he is doing without looking at the plate



A recording device, at left, worn by the cyclotron workers, is tested at intervals to guard against excessive absorption of the deadly radiations

The most common use of tagged atoms in biological research begins with the administration of the substance as a simple inorganic compound. The course of the exploding atoms is then traced and the distribution of the tagged element determined by several means. Body fluids are examined for radioactivity, and in the case of animals and plants samples of tissue are obtained for study. In the case of a living man or animal the progress of the exploding atom may be followed by placing a Geiger counter, the tube of which is so sensitive that it records stray cosmic rays, over the region of the body where the substance may be expected to accumulate. This device, in connection with tagged iodine atoms, has been extensively used in studies of the metabolism of the thyroid gland in normal and goiterous humans.

Distribution of the radioactive substance may also be determined by means of photography. When this method is used the animal is first fed a tagged element. Then it is dissected, and slices of prepared tissue are placed against a photographic film and left there for a period of time. The exploding atoms produce enough light to expose the film, which is developed in the normal manner. On it will appear a picture, known as a radio-autograph, of the actual distribution

Guarded by a mask, apron, and gloves made of lead-impregnated material, the operator puts the radioactive substance in a bottle. It is now ready for use as "tagged atoms" in biological research

of the tagged material through the tissues.

The radioactive substance most widely used at present is phosphorus, which, in both organic and inorganic compounds, is found in relatively large amounts in the tissues of all living organisms. Researchers have found that this material, administered to animals in combination with disodium phosphate, is retained in decreasing amounts by the bone, muscle, liver, stomach plus small intestine, blood, kidneys, heart, lungs, and brain. All of these tissues, excepting the brain, take it up rapidly.

Radioactive phosphorus has also been employed in experiments with plants. In one series of studies the substance was fed to the roots of tomato plants, and several days later the leaves and fruit were removed. Radioautographs indicated that the phosphorus had accumulated in the seeds of the green fruit and in the conduction system of the leaves. They also demonstrated conclusively that assimilated phosphorus can move downward as well as upward in the aerial portions of the tomato plant. In another experiment, tagged phosphorus was applied to the roots

TOMATOES from a plant fed with the radioactive phosphorus show how food is distributed through the maturing fruit. The whitest areas in photos are at points of greatest concentration. All these were green fruit. In the radio-autograph at right, food is seen in the stem and the leaves of a plant

of cotton, willow, and geranium plants, with the bark carefully detached from the wood and held away with the aid of waxed paper. Study of the wood and the bark showed that the assimilated phosphorus is transported to the aerial portions of the plant by way of the wood, and that the bark draws its mineral nutrients from the conducting vessels in the wood. Other tests with tagged substances have shown that, contrary to accepted theories of plant nutrition, plants can draw food directly from particles of soil; and that they can take up carbon dioxide without the presence of light.

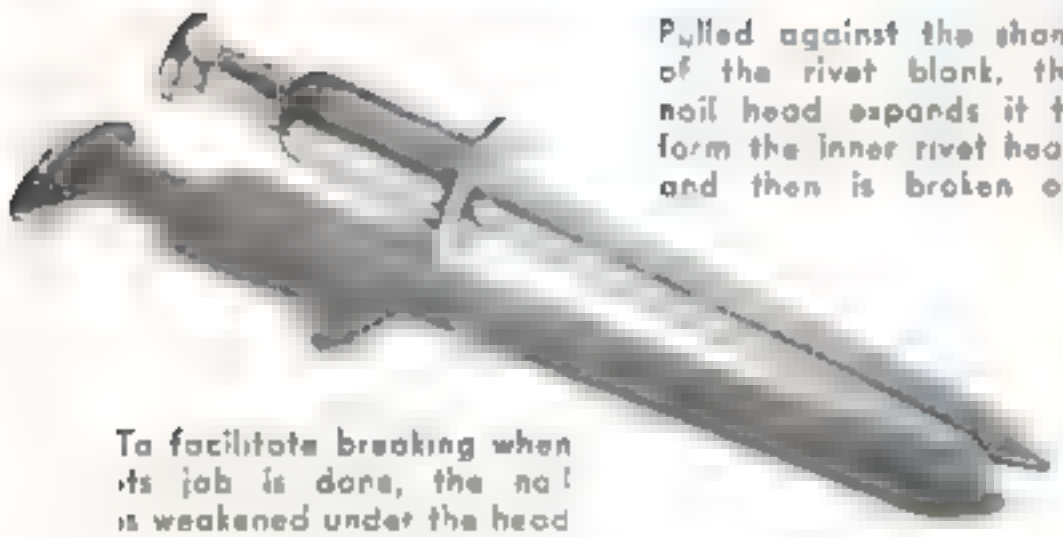
Through the use of radioactive calcium research scientists have learned that enzymes of the body break down minerals and other food components faster than had been supposed. Calcium is found in the milk of cows within a few minutes after the mineral is consumed, whereas it had been assumed that this required days. With radioactive strontium, a substitute for calcium, biologists are studying the growth of teeth and bones.

IN THE HUMAN BODY, the amounts and progress of a radioactive isotope can be determined with a Geiger counter, an instrument resembling a three-stage radio amplifier. A tube (left) filled with argon is placed over the part of the body to be tested. Beta or gamma rays given off by the radioactive material break down electrical resistance between the filament and shell of the tube, giving rise to a small current of electricity which is recorded on meters or audibly. The tube is so sensitive that it picks up cosmic rays

Blind Rivets

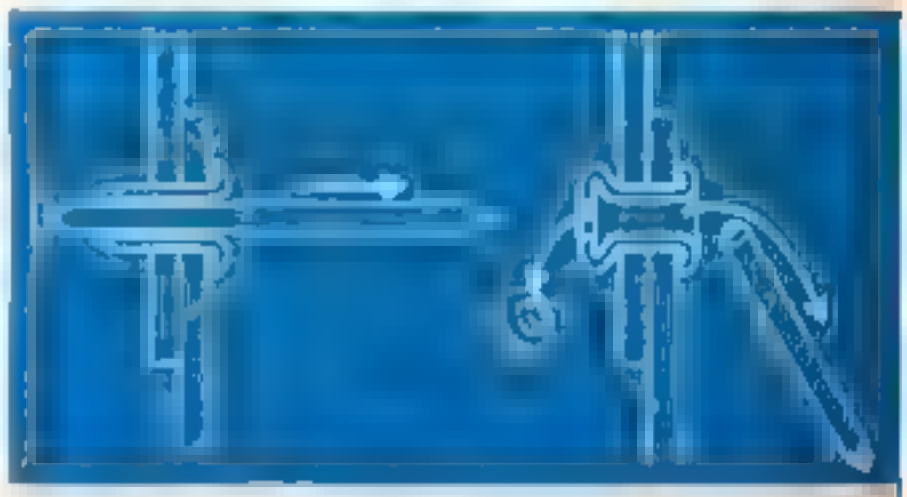
ARE SET QUICKLY FROM OUTSIDE WITH DOUBLE-ACTION GUN

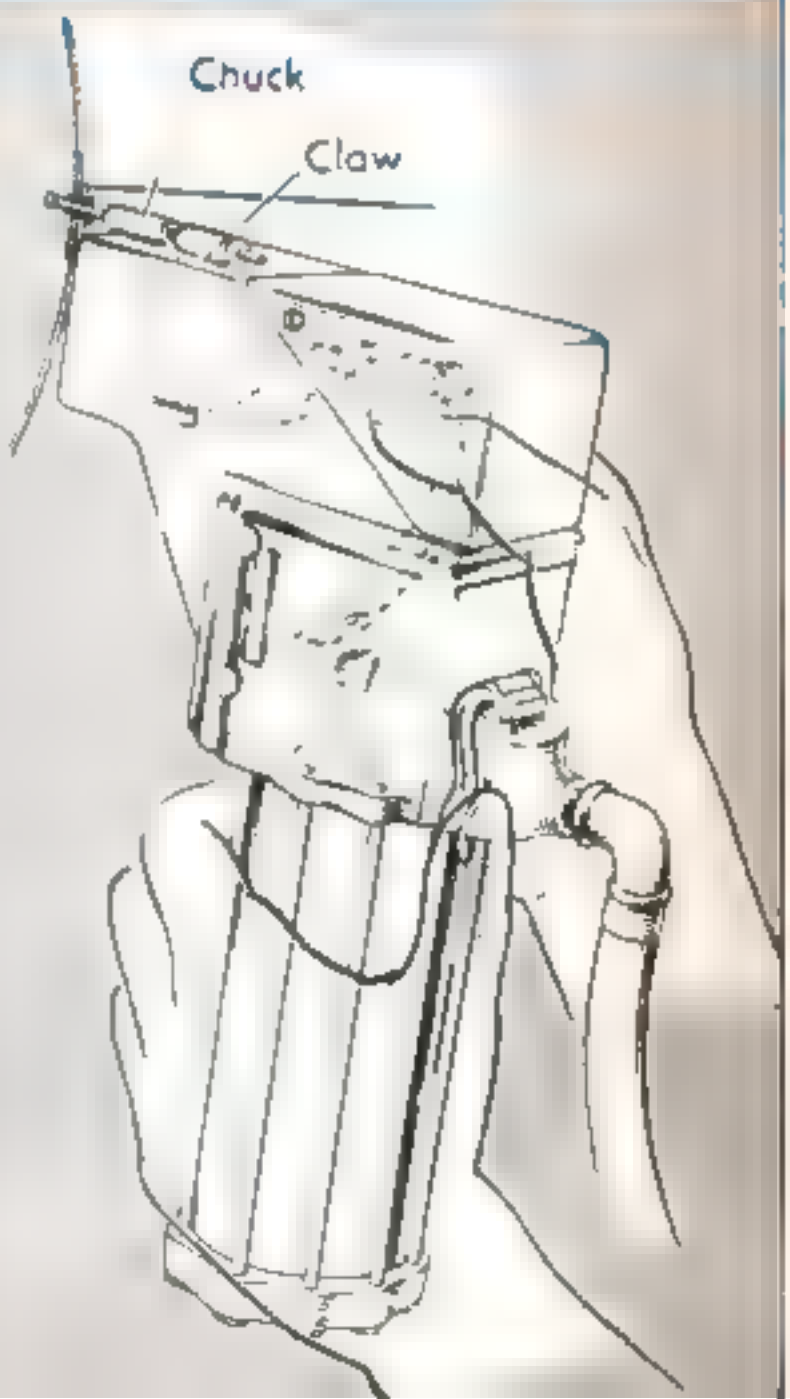
Tubular rivet blanks, slipped over "necked-down" nails, are fitted into rivet holes and automatically set with a squeezer



Pulled against the shank of the rivet blank, the nail head expands it to form the inner rivet head and then is broken off

To facilitate breaking when its job is done, the nail is weakened under the head

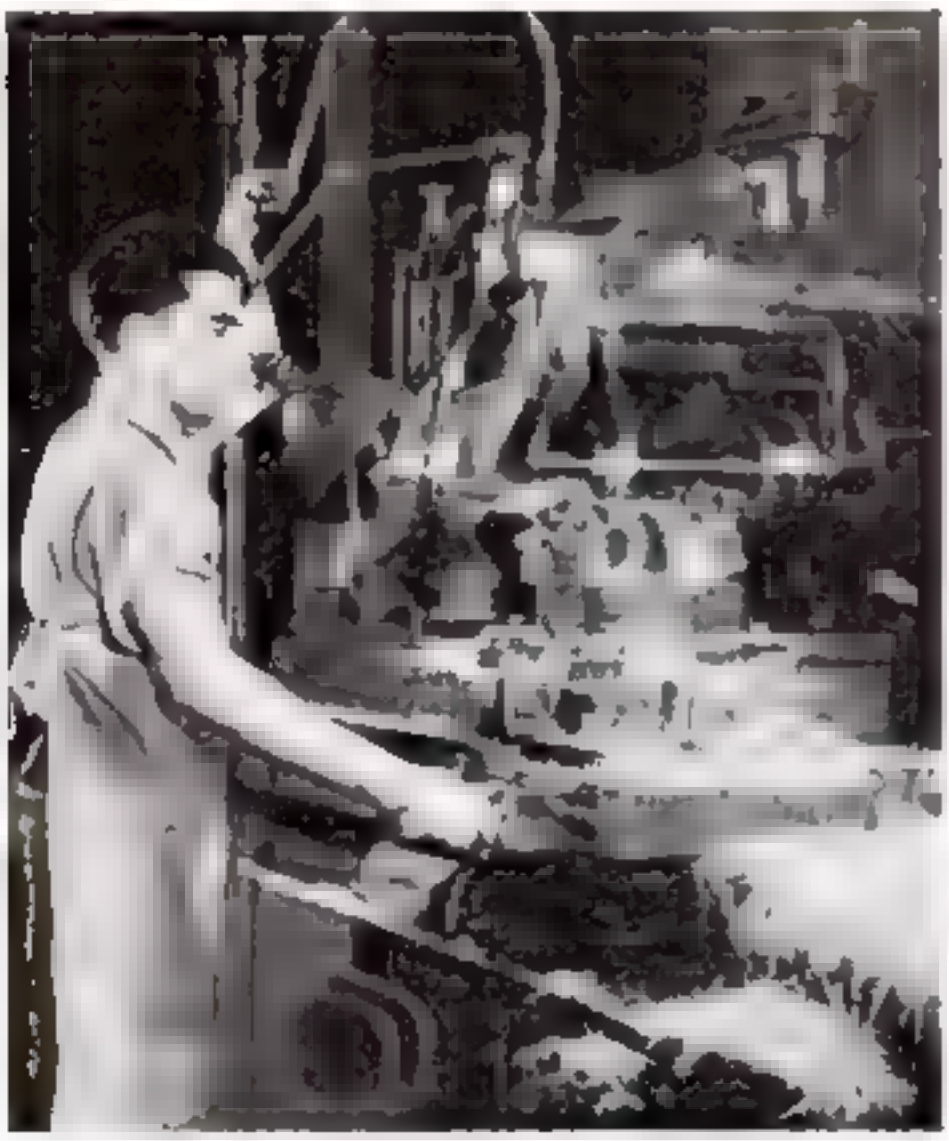




RIVETING "blind spots" in the wings and fuselages of airplanes has been simplified with a new-type rivet that can be fastened entirely from the outside. The rivet is tubular and is slipped over a commercial nail which has been "necked-down," or weakened slightly, under the head. Rivet and nail are put into a rivet hole from the outside then pressed together by a pneumatic squeezer equipped with a special claw which grips and pulls the nail shank, and a chuck which presses firmly against the rivet's lip. This expands the shank of the rivet to form an inside head, the nail breaking off at the neck automatically when the action is completed. Pop rivets, as they are sometimes called, are in various sizes and of many materials for different jobs, and can be stamped out of strip stock at the rate of 110 a minute in an automatic eyelet machine

This double-action gun is equipped with a chuck which presses the rivet's lip and a claw which pulls the nail to expand the rivet from inside

Forged Cylinder Head Gives Plane Engines More Power

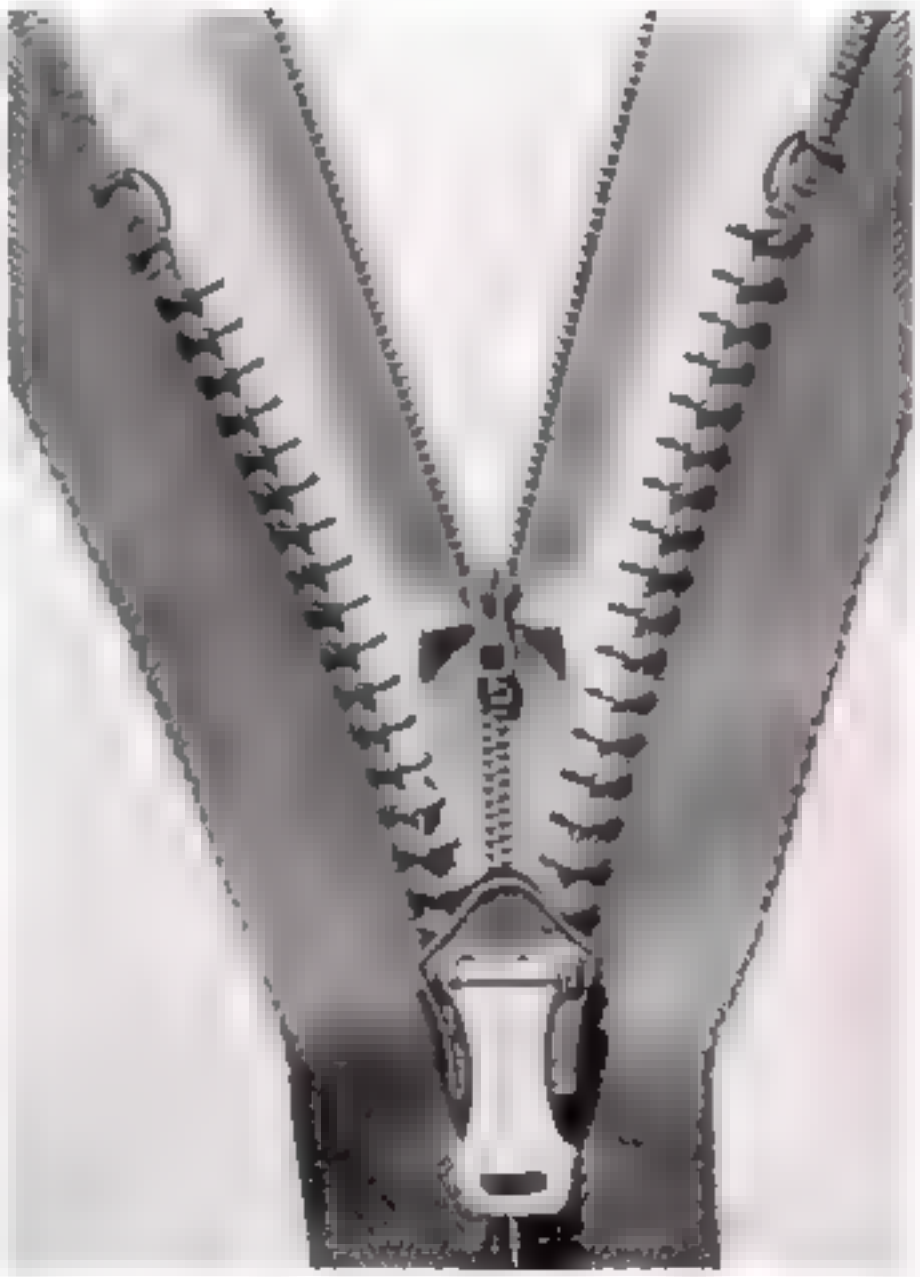


A special milling machine cuts the long, thin cooling fins into a forged cylinder head. At the right, the finished head is seen beside the rough forging

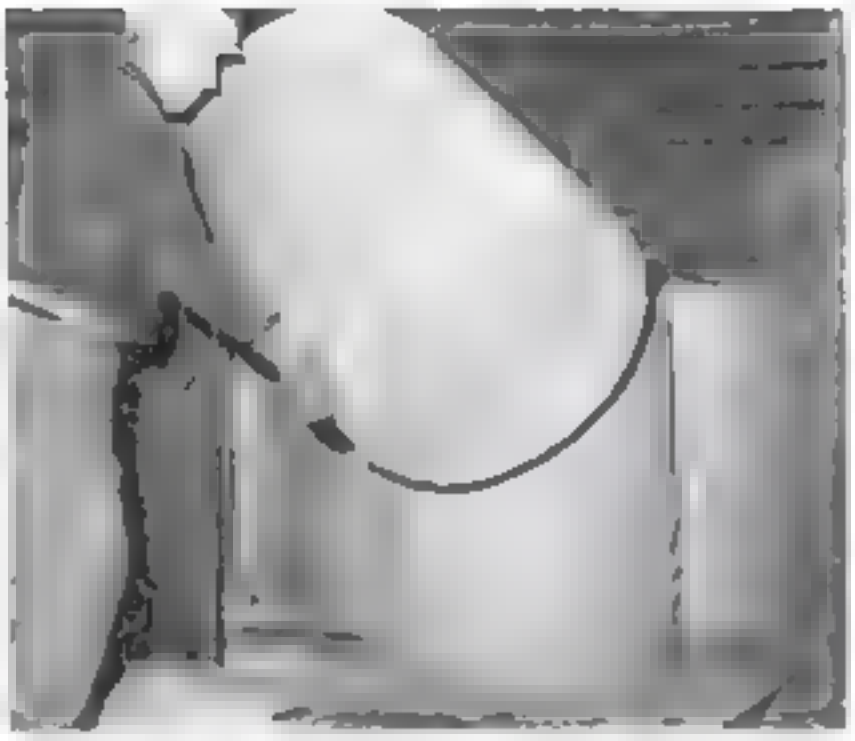
A FORGED cylinder head for airplane engines, sought for more than a decade by manufacturers of air-cooled motors, has been developed by the Wright Aeronautical Corporation. The new head, made of machined aluminum alloy, gives 30 percent better cooling than the type now in use, and is twice as strong. This greater strength will permit higher pressures, and increase the power output from 15 to 20 percent per cylinder. It weighs 3½ pounds less than the old head. Its improved efficiency brings the pound-horsepower ratio down to less than one-for-one and gives American planes definite superiority in speed and range.

Big Berthas Do Strip Tease with Jumbo Slide Fasteners

THE largest and strongest slide fastener ever made, appropriately called the Jumbo, is being manufactured exclusively for America's fighting forces by the Crown Fastener Company of New York. It was specially designed for use on the covers of such heavy military equipment as bombers, tanks, cannon, and machine guns, and is said to have reduced materially the time necessary to put these weapons into action. The usefulness and wearability of the new fastener were increased by several new features, including a new type of bent tooth, with rounded ends, which enables the edges of the cover to close at an angle instead of parallel. A longer leg also has been provided for the cloth tape. In the photograph at the right, the giant slide fastener is shown exactly one-half actual size, compared with a standard dress-placket fastener. Before the war, the Crown company manufactured the dainty slide fasteners sold to housewives for home sewing. With the emergency, the firm converted its facilities to making the strip-tease fittings for Big Berthas.

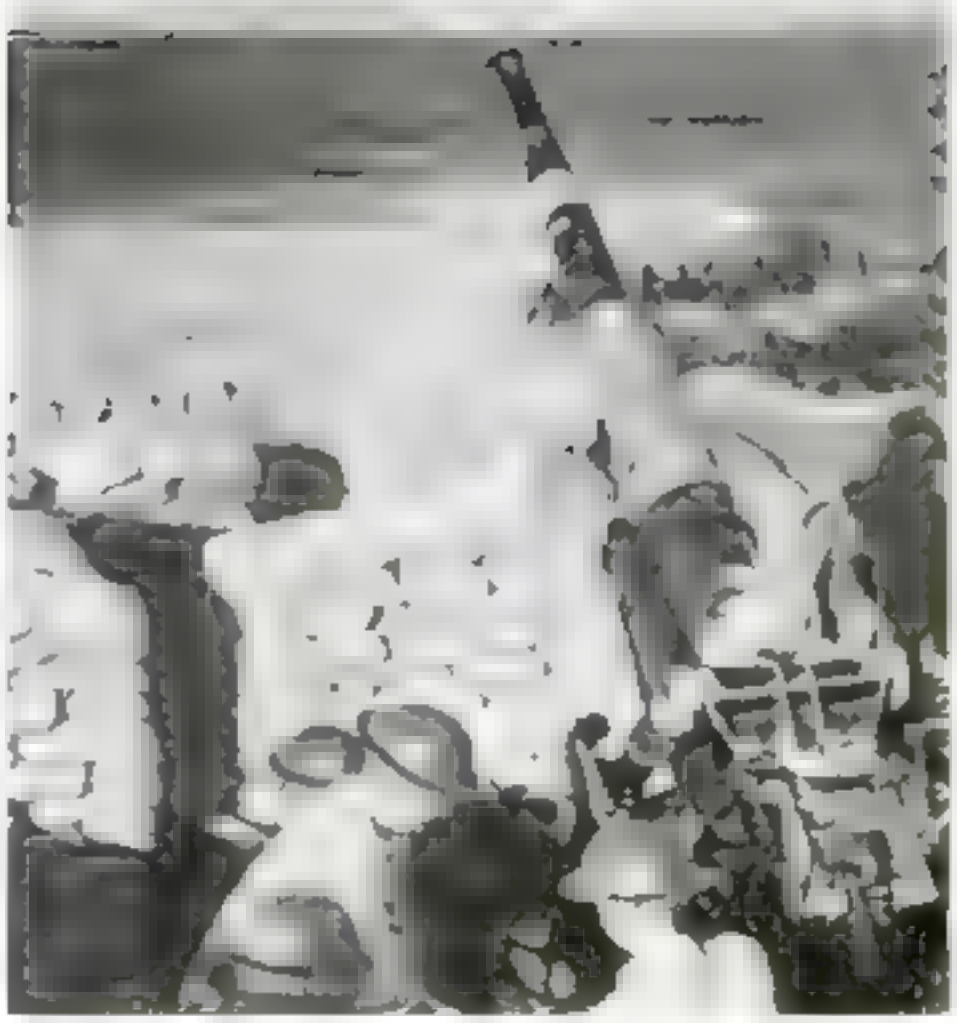


MADE TO MEASURE FOR MODERN WAR



Fabric for sandbags is treated at the factory with a preservative to make it resist mildew

Women making bags at a factory in Brooklyn, N.Y. Below, piles of bags await shipment to the front lines. Note built-in drawstrings



One way they are used: an antiaircraft-gun emplacement in Puerto Rico, with sandbagged revetments

IMPROVED sandbags, tailored to fit military needs, are being turned out by the hundred million at the factories of America's largest manufacturer. More compact than old-style bags that took two men to lift, they may be filled with a twist of a shovel and handled with ease. Built-in drawstrings are tied in a jiffy. Raw materials, burlap and another fabric called osnaburg, receive a chemical treatment that makes them mildew-proof, multiplying their life from three to eight times. The damp sand of tropical climates cannot rot them. Osnaburg bags are dyed to make them less visible to enemy observation planes; burlap needs no dyeing

A twist of a shovel is all it takes to fill one of these improved bags. Drawstrings make closing easy

Tiny Brazilian diamonds (here highly magnified) are the raw material of a war-production "must"

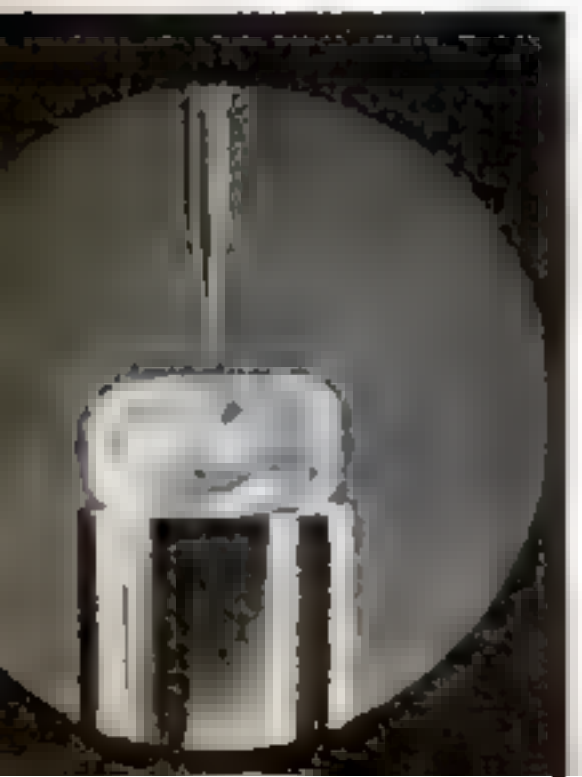
DIAMOND DIES....

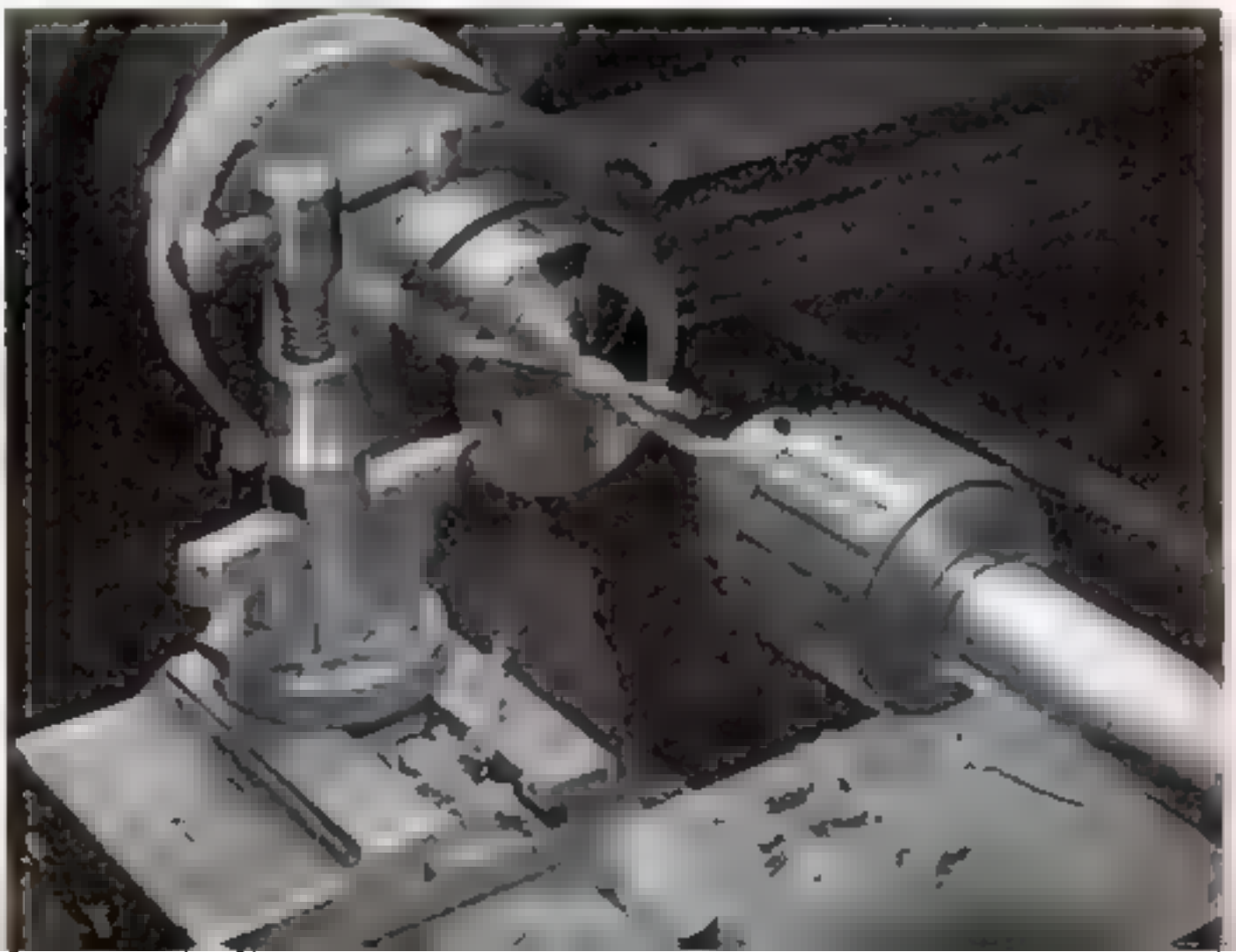
Armament's Tremendous Trifles

TRIPLE-0 diamond dies are armament's tremendous trifles. Tremendous in their importance to our war effort because without them we would not be able to produce wire of gossamer fineness for the superdelicate instruments which make it possible for our giant bombers to fly accurately on their hazardous missions and for our big guns to hit their marks. Trifles in size because a triple-0 die is a Brazilian diamond weighing only 1/800 of an ounce, that has been pierced expertly with a bell-mouthed hole

1 MAKING A DIAMOND DIE. The first step in making a diamond die is to prepare the nib, a soft metal setting in which the diamond is embedded before drilling. In the photograph below, a hole is being bored in the nib to receive the diamond

The object is to drill a tiny bell-mouthed hole smaller than a human hair through a small industrial diamond with a fine smooth needle





smaller in diameter than a human hair.

Less than two years ago the only people in the United States who could make these very small dies were an elderly Frenchman and his wife and schoolgirl daughter. Except for the limited production of this family, in which the time-honored handwork methods of European die makers predominated, all diamond dies below the .004-inch size were imported from France.

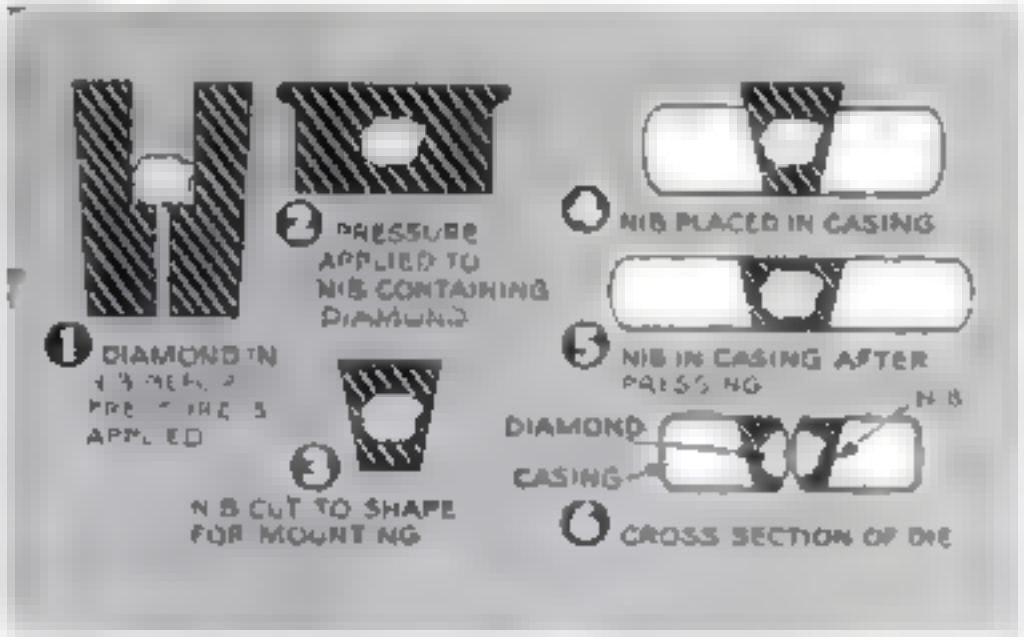
Today there are several hundred American workers who are producing superlative diamond dies of all sizes with newly developed machines. A half dozen shops now are making dies smaller than .0008 inch, and Government-financed expansion of manufacturing facilities and training of new workers soon will make us self-sufficient.

Alexander Shayne, a New York engineer, is the man chiefly responsible for this breaking of a potential bottleneck. Having had considerable contact with the diamond-die industry, he knew its importance and its problems. When the National Defense Advisory Committee was formed in 1940 he joined it to devise and carry through an expansion which would assure us of an adequate supply of the dies. He is continuing this work for WPB.

Diamond dies are used for the drawing of fine wire that must be absolutely uniform in size because they are both more accurate and more durable than the steel dies used for coarse wire. The wire is cut out of sheets of metal and then drawn through a die to shape it and to reduce it to the diameter of the hole in the die. A really good diamond die will draw almost 100 000 feet of wire before it becomes inaccurate because of the enlargement of the hole through which the wire is drawn. The die may then be rebored to draw wire of a slightly larger size.

Shayne found that we had a stockpile of industrial diamonds large enough to meet current needs and those of the near future. As these diamonds are imported from Brazil and a single airplane could carry enough of them to supply the demand of the entire world for a number of years, there was no reason to fear a serious shortage of them.

The situation concerning the larger-sized diamond dies was

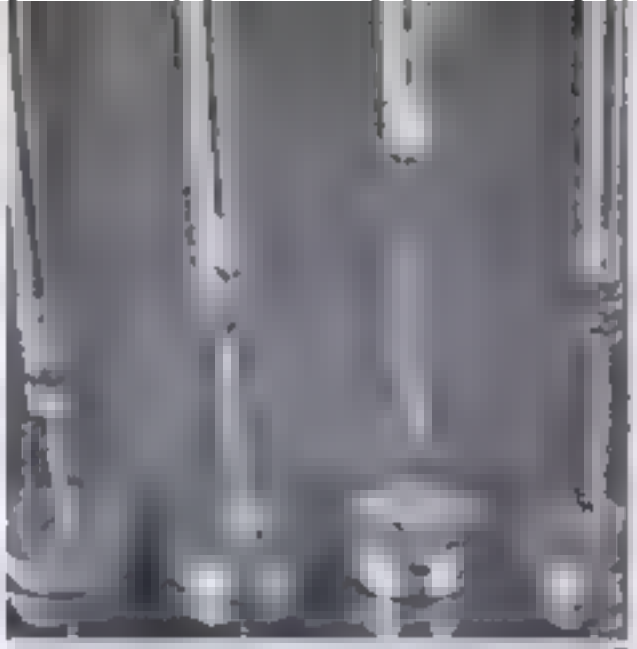


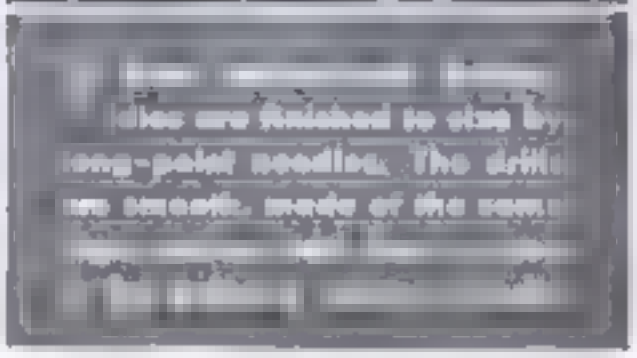
2 With the diamond inside the nib is squeezed together and relathed with a slight bevel to fit into the permanent metal die casing, as shown

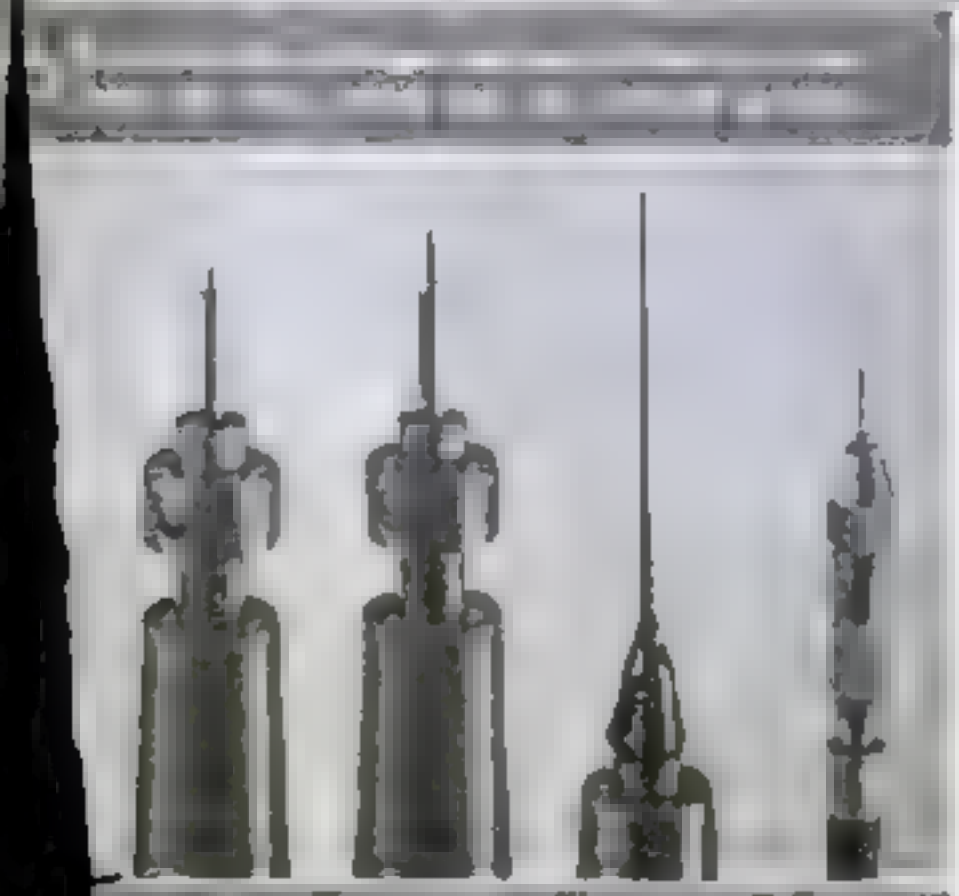
3 This is placed in a special outer casing for drilling The diamond rests in the center of the die, ready for the difficult drilling process

4 Now a small diamond chip is selected for the spotting operation, in which a small indentation is made in the die to help start the drill

5 Holding the spotting diamond carefully with a pair of pliers so that a sharp corner is presented, the worker presses it against the die

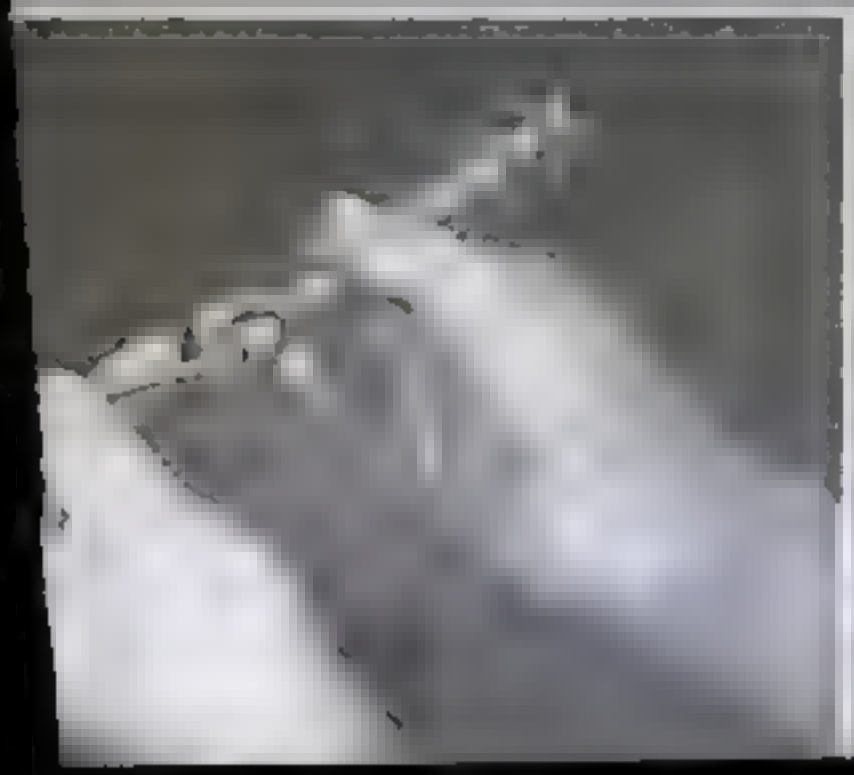


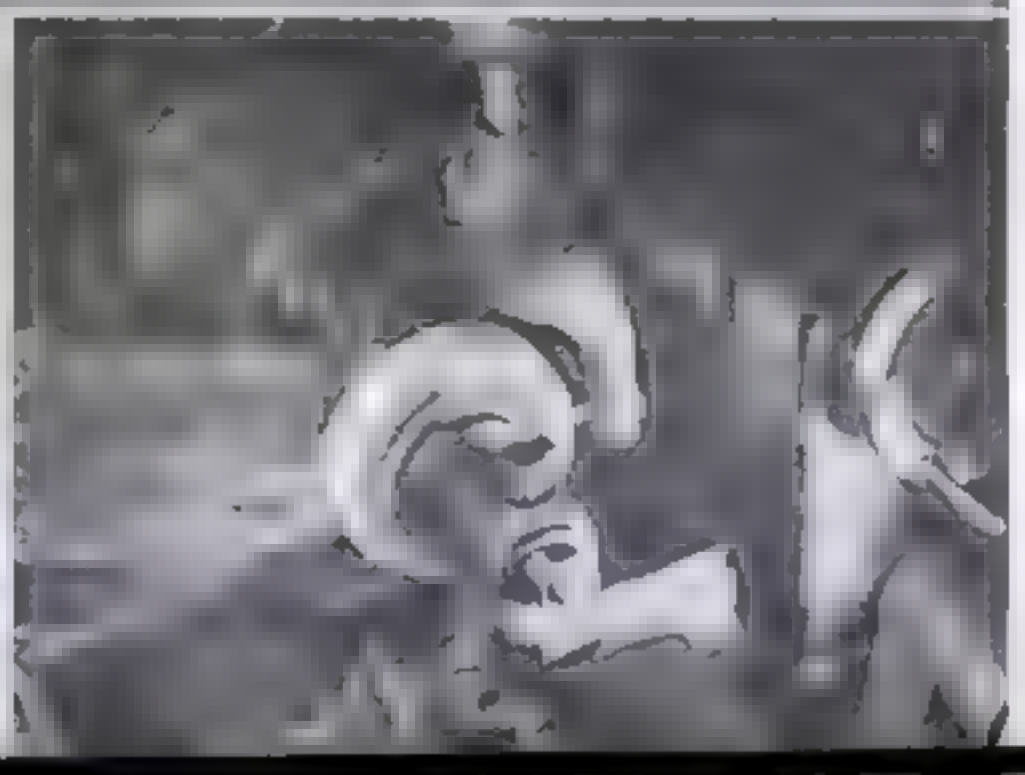


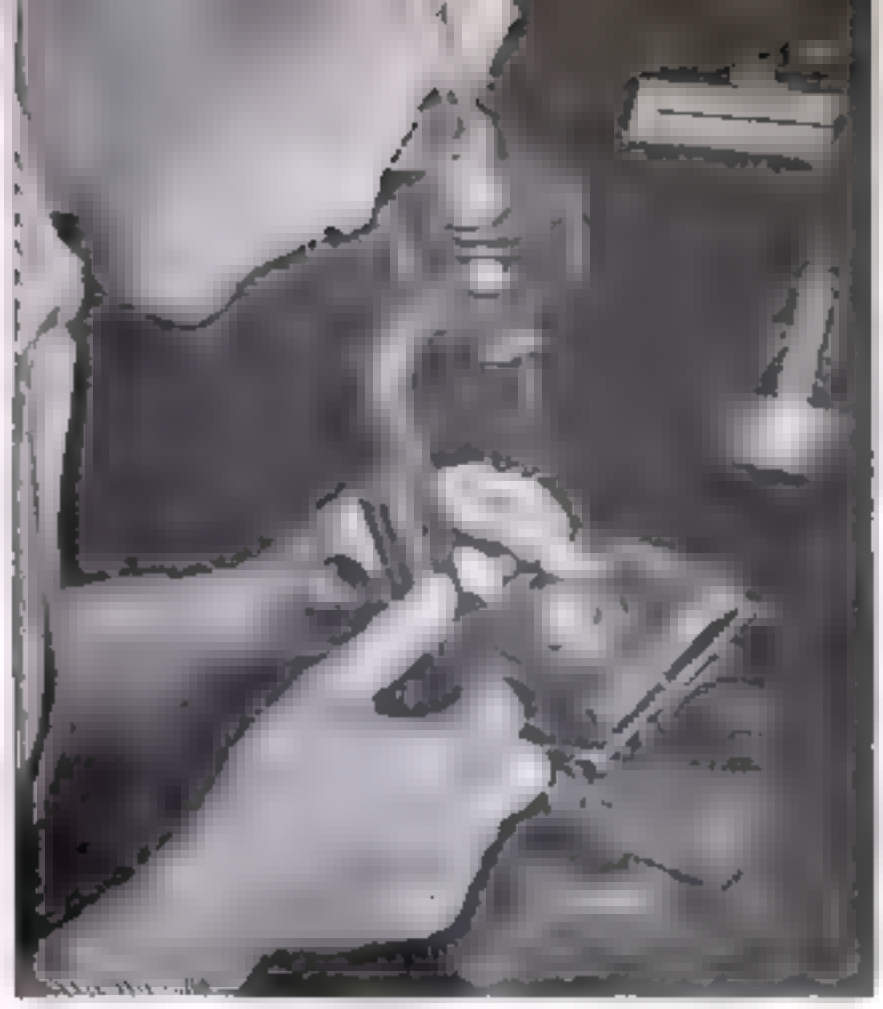


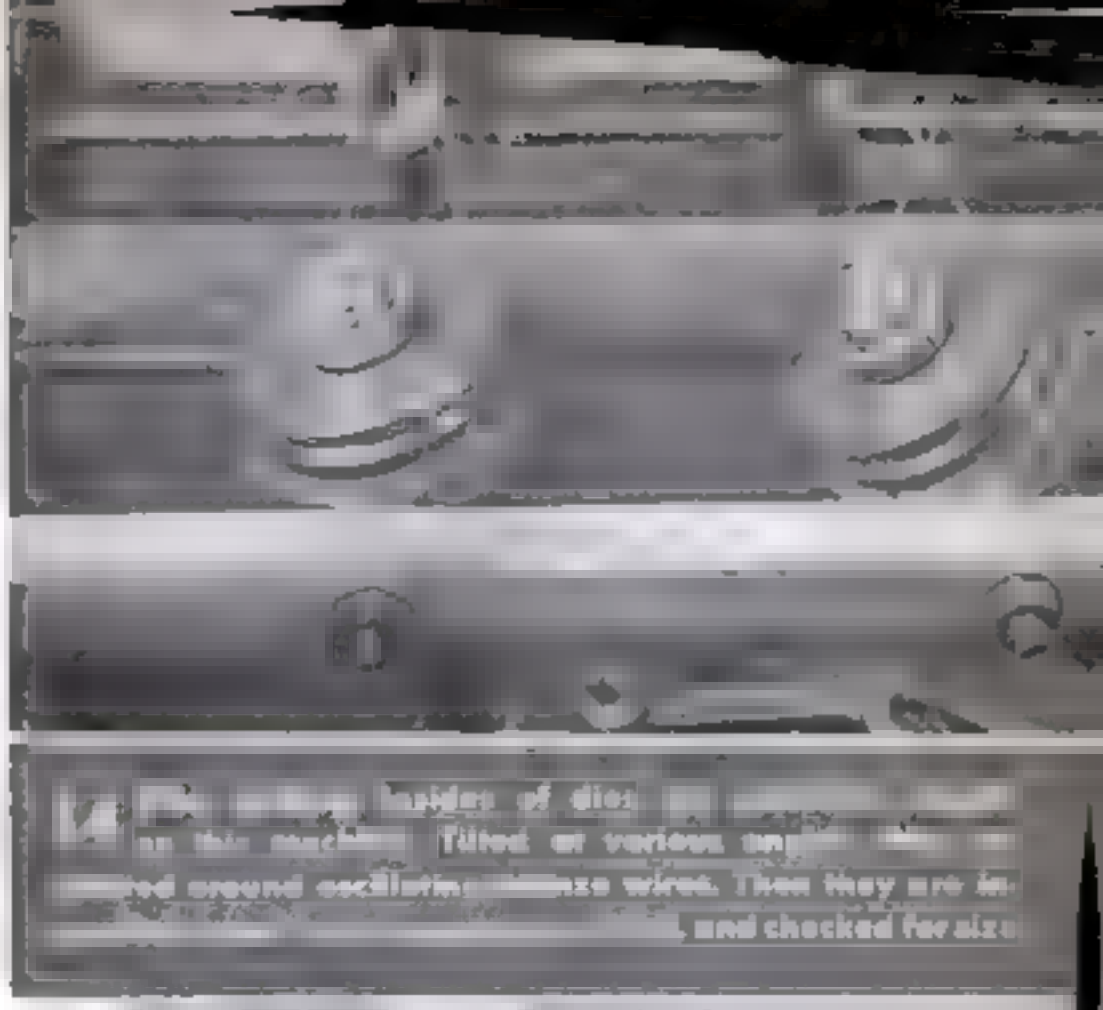
equally favorable. American die makers had been producing them by machine methods for years and all that would be needed was to expand their existing facilities. But the situation concerning the small-size dies was downright frightening. Except for the three French people mentioned earlier, no one in the United States had any experience in the making of dies smaller than .004 inch and .0008, .0006 and even .0004-inch diamond dies were and would continue to be needed badly.

In the past these very small dies had been imported from France, where there were several thousand expert diamond-die makers, many of them members of families who worked together in their homes. But imports of the dies made by these people had been cut off after the fall of France, and anyhow they wouldn't have been sufficient to meet our needs. The output of the French experts is small because most of them do at







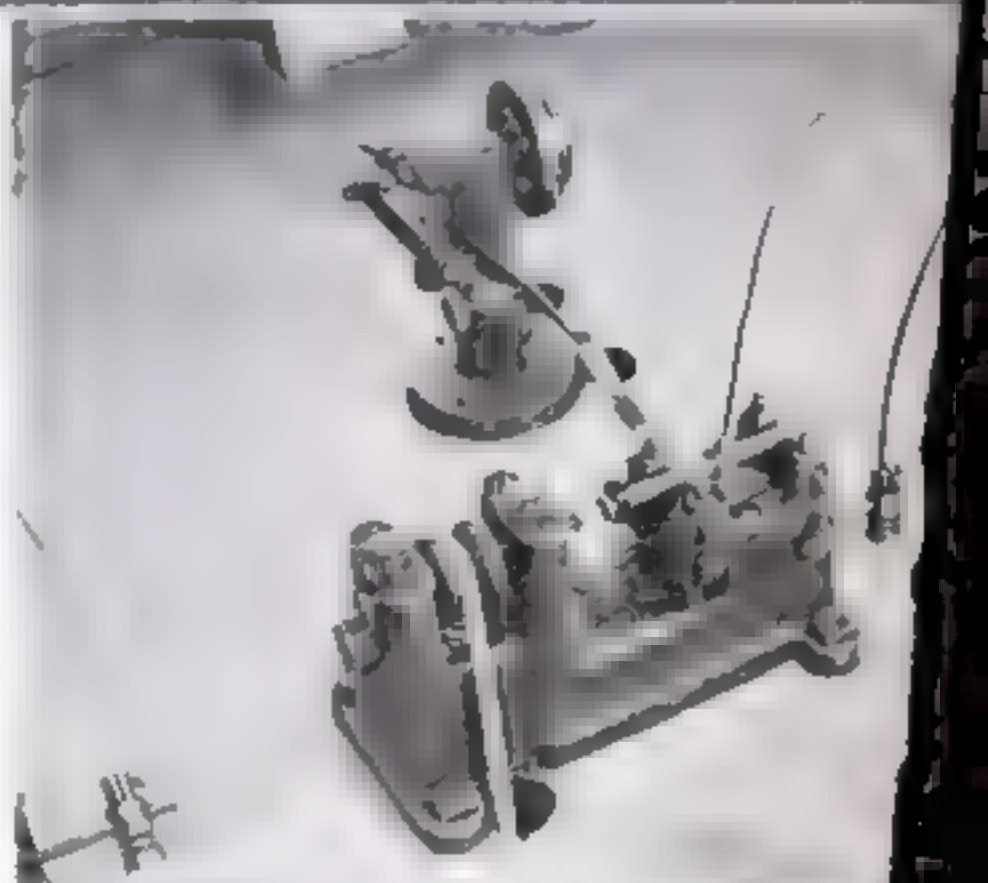


[illegible] holder of dies [illegible] on this machine [illegible] filled or various sizes [illegible] wound around oscillating [illegible] wire. Then they are [illegible] and checked for size

least three quarters of their work by hand, often by wearing tiny holes in the diamonds by poking at them with continually sharpened needles for hundreds of hours. Producing a perfect die of very small size by this handwork method is largely a matter of chance. Experts say that of every 100 dies drilled to .0004-inch size by European experts only three are accurate

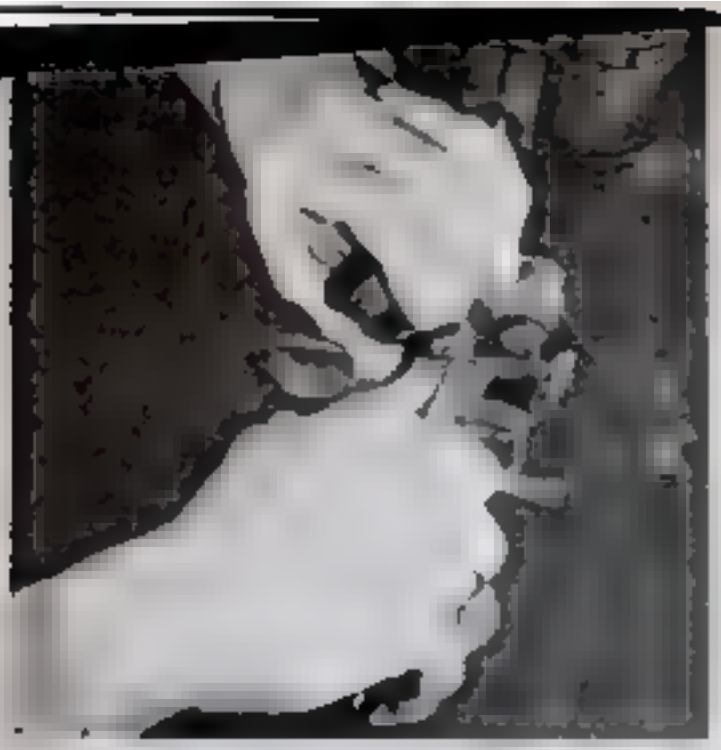
It was obvious that our diamond-die makers would have to learn in a few months an art which the French worker gave most of his lifetime to learning. They would have to devise machines which would do the work better and much faster than the French experts ever had been able to do it. They would have to select and train workers to operate those machines

Shayne turned himself into a traveling one-man information bureau for the manufacturers. The die makers risked their time



[illegible] curves in the bell-like mouths of the die. If these

13 [illegible] single-spindle horizontal machi[illegible]



Spotting is done by the French experts on a primitive-looking foot-powered machine. European die making is slow because most of the work is done by hand

Foot-treadle operation gives more delicate control for workers schooled in European craftsmanship. Division of tasks now speeds die output

Power for the spotting machine comes from this big wooden wheel. American production methods have cut the time required for making a small die to 20 hours

NUCLEUS of America's newly created triple-O diamond-die industry was an elderly Frenchman and his wife and daughter. Two years ago, they were the only persons in the United States who could do this fine work, and they have helped to train American workers. These pictures show the patient handcraft methods they employ

and money in experiments, and when they had proved that they could produce dies of the required fineness the Government financed the expansion of some of their plants. The family of French die makers helped greatly in the training of new workers. They now have a small modern factory of their own; their name can't be given because they have relatives who are die makers in France. Hitler's *Gestapo* has a heavy hand at the end of a long arm.

Six months after Shayne started his drive a half dozen diamond-die manufacturers who never before had made dies smaller than .004 inch were turning out the .001-inch size in considerable quantities. Now several firms are producing the highly prized triple-0 dies. Girls who a year ago were in high school are operating newly invented machines which drill .0004-inch diamond dies—and instead of three they're turning out 80 perfect dies in each 100 they drill!

Recently I saw diamond dies being made in the closely guarded plant of the largest American manufacturer. A modern factory in miniature, it consists of a small office, a small combination inspection and stock room with an impressively big safe, and two narrow, well-lighted shops lined with small, quietly whirring machines tended by men and girl operators. In France a diamond-die maker is a master craftsman who makes the entire die. In this factory the making of a die is broken up into 27 operations, and the worker is taught only one of them. This makes training a matter of weeks instead of years. Girls, I was told, usually learn a little more quickly than men.

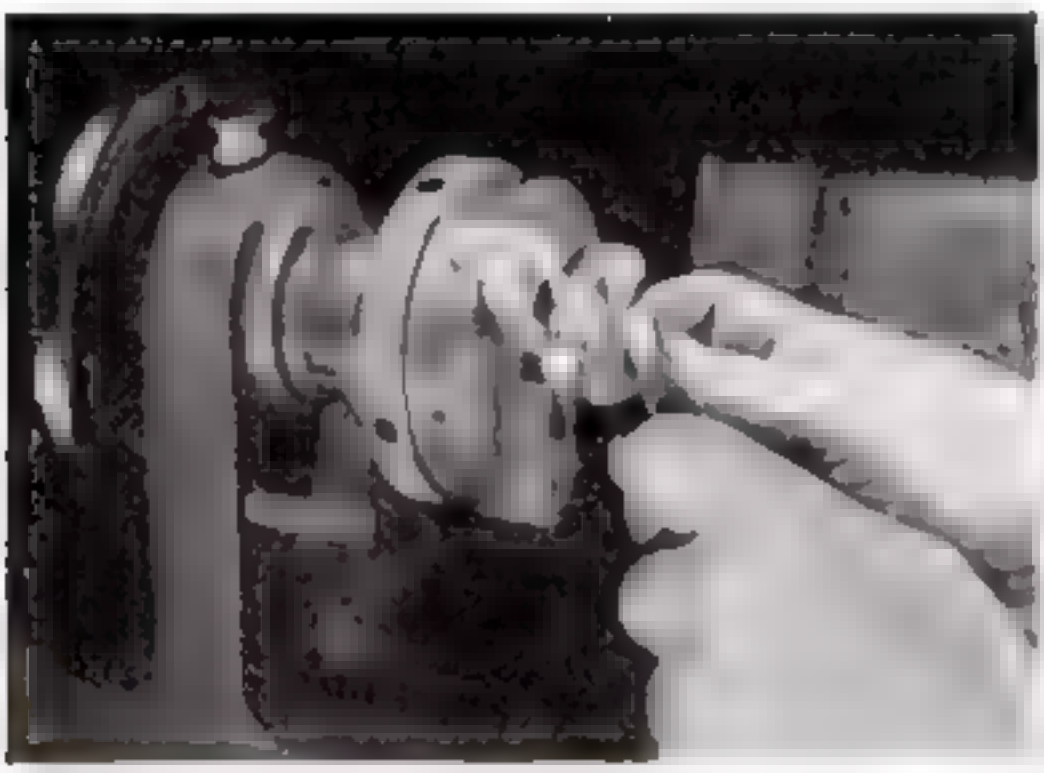
For a small die, an industrial diamond of about 1/5 carat, with a height of about .06 inch, is selected. The first operation is the flattening of the diamond by grinding its

top and bottom parallel. Then a "window" is ground on one of its sides, to enable the operator to watch the progress of the drilling through a microscope attached to the drilling machine. The diamond then is "prespotted" by a slight indentation being made in its top by hand. Then it is mounted in a drilling machine. The stone is held in place by vaseline, which permits it to move slightly and so adjust itself to the position of the needle. The spotting process is completed by the machine, and the stone is ready for drilling

The larger-size dies are drilled by ten-spindle vertical machines. Dies between .002 and .01 inch are drilled on single-spindle horizontal machines. Very small dies are drilled by a recently perfected horizontal machine —of which more later. A competent worker can tend six or eight machines.

The drill used for drilling diamond dies is a smooth needle made of the same high-carbon steel that is used for ordinary sewing needles. It must be about two microns (.002 mm.) smaller than the die that is to be drilled. The most desirable speed for the needle is about 6,000 r.p.m. The abrasive used is fine diamond powder mixed with a newly developed mineral oil which is greatly superior to the olive oil used for the purpose in the past. The revolving needle does not press against the stone—the stone is pressed against the needle by an accurately adjusted spring. The pressure used is 75,000 pounds per square inch—which means that when a .0003-inch needle is being used the pressure exerted by the spring is only 8/100 of an ounce!

A drilling needle wears away about 15 times faster than the diamond it is drilling For this reason it must be sharpened frequently—sometimes 500 times for a single die. In sharpening the needle extreme care must be taken not to change its shape. Diamond dies would be comparatively easy to make if a straight-sided hole through the stone were all that was necessary. But a straight-sided hole would be much worse than useless. There must be a bell-mouthed entrance on one side of the die, then a hole of exactly the specified diameter, and then a bell-mouthed *(Continued on page 206)*



15 With the hole drilled and finished, the die casing is smoothed and polished. Here a piece of emery paper is pressed against the rotating disk

16 To test the completed die, a wire is drawn through it as in actual use. The purpose of the die is to reduce the wire to uniform size

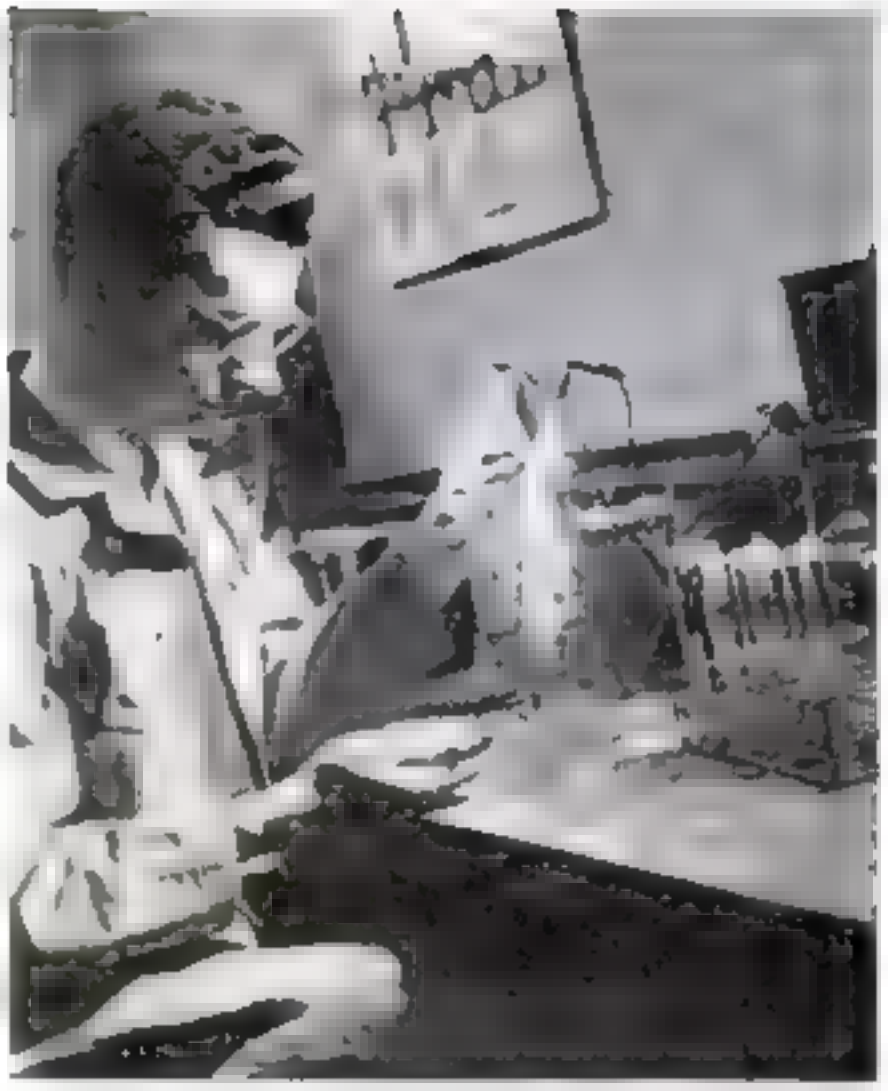
17 Wire drawn through the die under test is measured with a micrometer that gauges its thickness and so determines the exact size of the die . . .

18 . . . which is stamped on the casing for the guidance of users. Below is the finished product, ready for its part in war production

NEW SCIENCE IDEAS

Ray Lamp Sterilizes Bottles To Retard Souring of Milk

MILK bottles can be made completely sterile just before filling, with a new U-shaped ultraviolet-ray lamp developed by Westinghouse research engineers. Batteries of the lamps would be inserted in the bottles for ten seconds as they pass along the filling conveyor line. While the modern dairy sterilizes bottles chemically after washing them, the final rinsing usually is with city water which contains bacteria. In most cases harmless, these bacteria nevertheless speed the souring of milk. The lamps leave the bottles bacteria-free, thus keeping milk fresh hours longer than usual.



Testing an ultraviolet-ray bottle-sterilizing lamp

Left, a completed TVA dwelling. Wheels under the corners of each of its sections sped them through assembly lines, onto trucks, and then onto a prepared foundation

Below, one of the sections. It contains all the plumbing and principal wiring for household fixtures in the adjoining rooms

House Sections Roll on Wheels To Speed Building of Homes

DWELLINGS being built by the Tennessee Valley Authority for temporary housing projects literally roll on their own wheels in complete sections from assembly lines to trucks and thence to prepared foundations. Sections contain one room, finished from floor to roof, and the number of sections per house is determined by the worker's family needs. The wheels are small metal pulley wheels at each section corner, and one-inch pipe forms the tracks for both the assembly line and the house foundations. One narrow section for each house contains all the wires and plumbing, ready for connecting.

Fire-Retardant Roofing Mastic Resists Incendiary Bombs

Spread over roofing like cement, this mastic guards against fire bombs. At right, shallow craters with little fire damage from two types of incendiaries

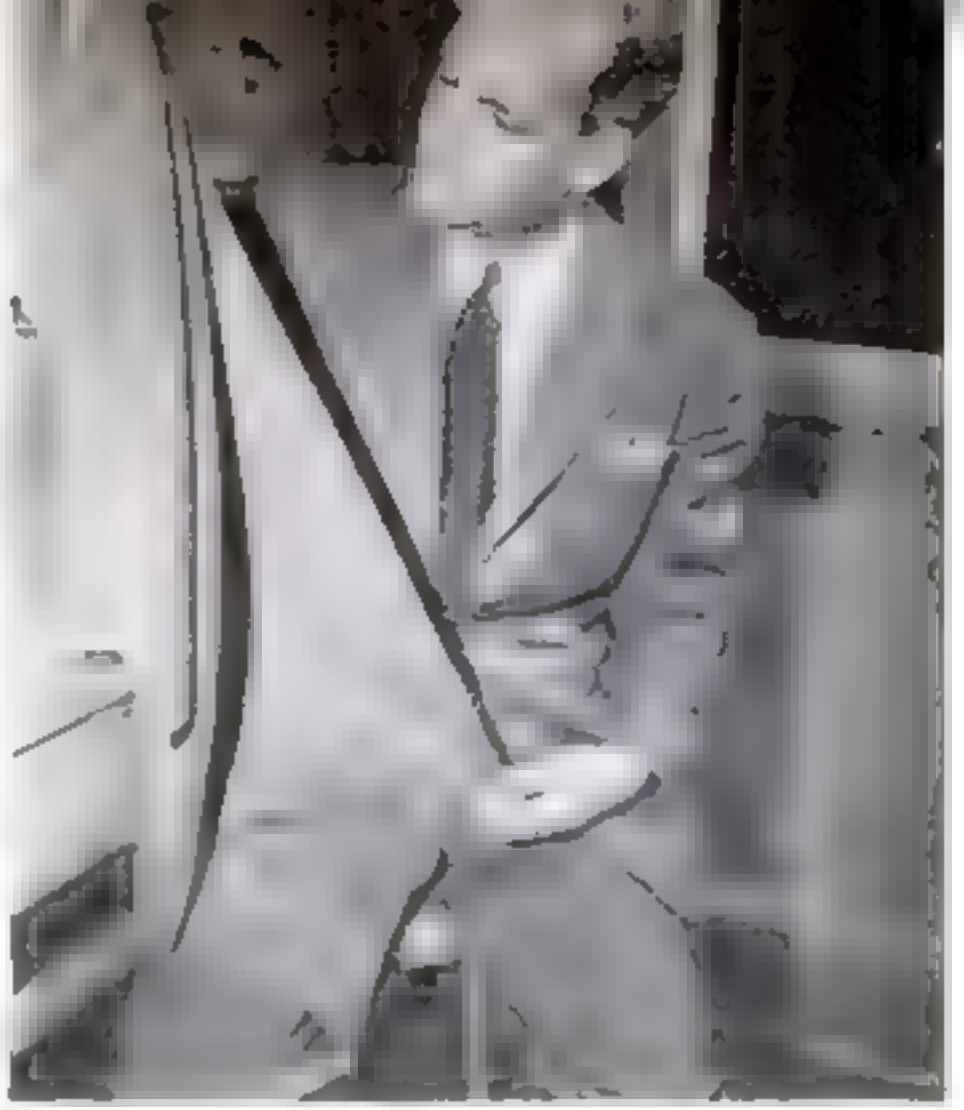
INCENDIARY bombs have little effect on a new fire-retardant mastic that can be applied to any flat-topped roof. The material can be spread on by means of a wooden float to a thickness of three fourths of an inch, dries up in from 12 to 24 hours, and then can be walked upon. Tested extensively in England during actual incendiary raids, the surface of the material is said to carbonize when an incendiary bomb burns on top of it. Although it cannot be applied to sloping roofs, the mastic can be put on attic floors if they are strongly supported so that they can bear the additional weight.

Douglas Fir's Bark Processed to Obtain Cork Substitute

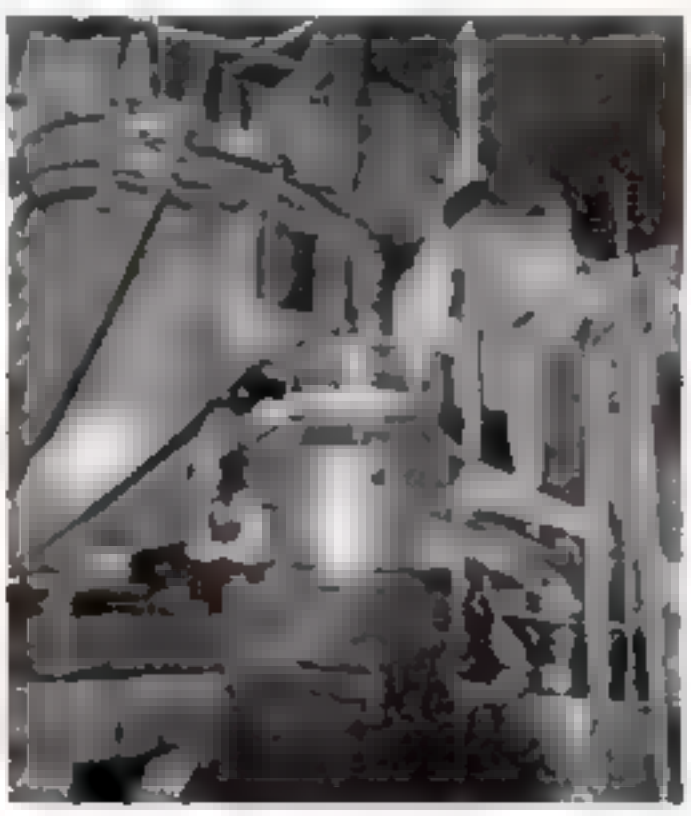
DOUGLAS fir trees, which grow abundantly in the high-altitude forests of the Pacific Northwest, are now being considered as a possible source of domestic cork to offset the shortage of that formerly imported. By experimenting with the bark, which is composed of two-thirds cork, two professors at the University of Washington have discovered a method of reclaiming the precious material. Although details of the process are secret, it is known that the bark of the tree is chopped into small pieces and then run through a machine which separates the bark from the cork. Because cork is used extensively in the manufacture of insulating materials and linoleum, the cork-lined bark of the Douglas fir may serve as a substitute until the war is over.

Ford Plant Starts Producing Synthetic Soybean Wool

MAKING synthetic wool from soybeans has passed from the experimental to the production stage in the plant of the Ford Motor Company at Dearborn, Mich. The product costs half as much as sheep's wool, which it closely resembles, and the two are blended for use. Applications are foreseen in upholstery and for other purposes, one of which may be forecast by suitings woven from the material. To make the fabric, the oil is extracted from the bean, leaving oil-free meal that yields a protein. This is dissolved, forming a viscous, green jellylike material, which emerges in strips like noodles from a 500-hole spinneret. Chemical treatments with acid and formaldehyde set the fiber, which then is cut, dried, spun, and woven into cloth. Operations at the new Dearborn factory follow several months of experimentation.

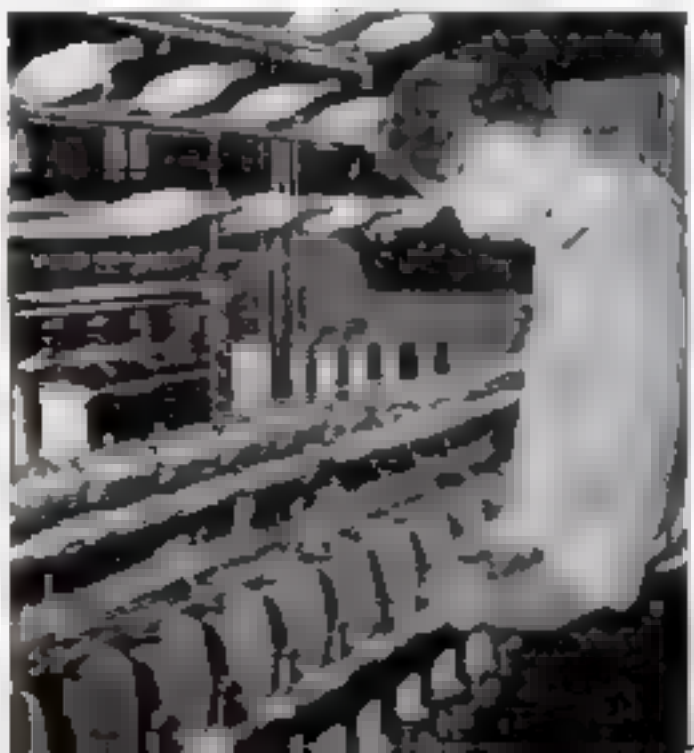


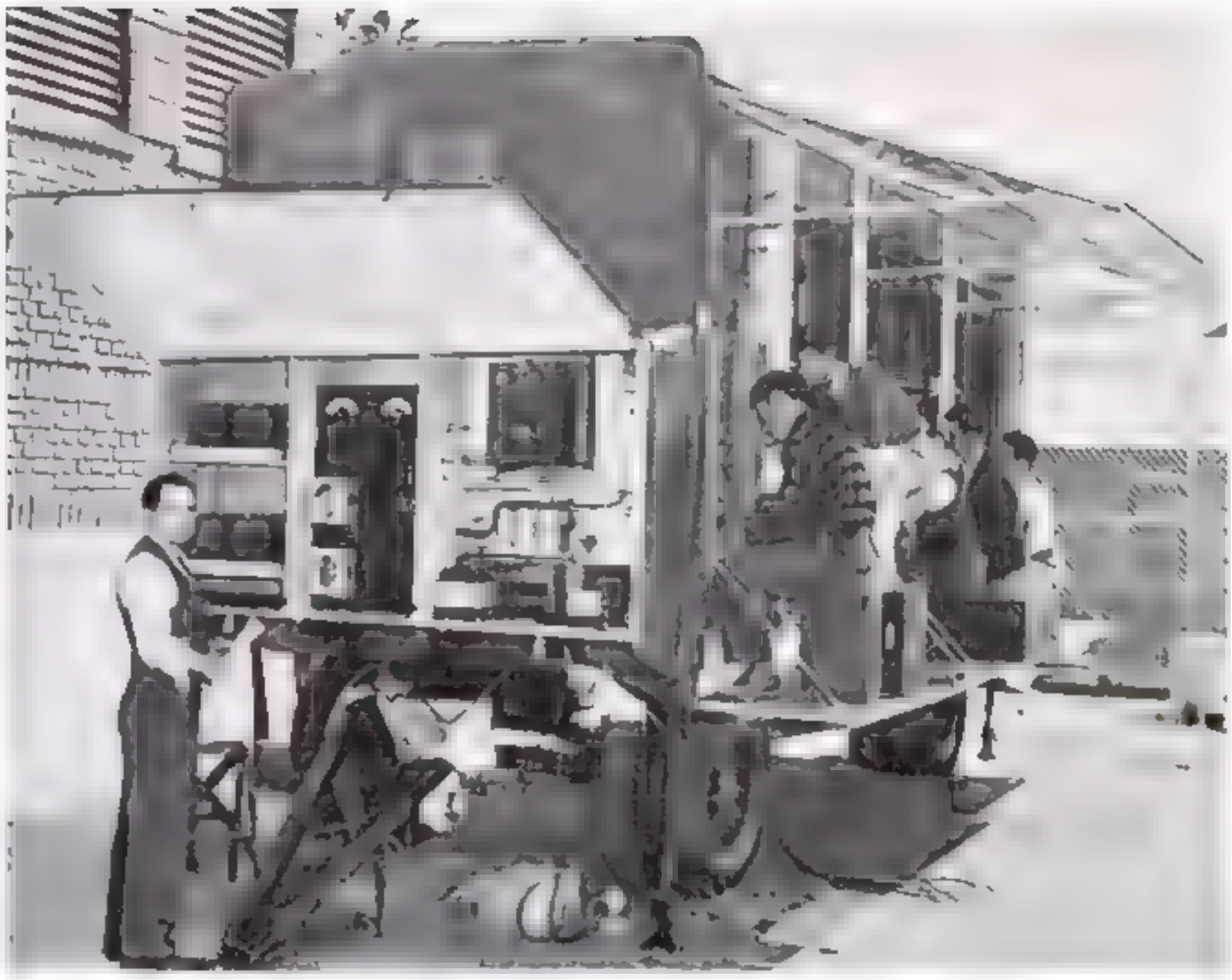
Robert Boyer, director of the new Ford soybean processing plant, examines a piece of suiting material made from the newly developed synthetic wool



A sack of oil-freed soybean meal comes to the mill. The first step (center, above) clarifies the soybean-protein solution. The solution emerges in a milky, liquid form. After further treatment, it enters the 500-hole spinneret or extrusion machine at right, coming out like noodles over a drum into a chemical bath

Cut and dried on racks, the soybean fiber now is ready to be spun into thread, either alone or mixed with sheep wool. At center, below, a twister machine is doubling yarn before its final winding stage. And at right is the end product—soybean-wool fabric, being woven on a loom for a wide variety of uses





Trailer-Borne Central Exchange Restores Phone Service

IF A main-line telephone cable is damaged near Los Angeles, service will be disrupted only until a speedy central-office truck and trailer can get to the scene. Equipped with a switchboard that will handle approximately 400 telephones, the trailer is a complete central exchange within itself When an emergency call comes to the main office, the truck speeds out to the damaged cable, a crew connects the broken wires to the trailer switchboard, and communications are restored until the damage is repaired. To stabilize the unit while it is in operation, a heavy jack is placed under each corner. The working side of the trailer opens upward to serve as an awning.

Goggles End Glare for Aluminum Welders in Plane Plant

INJURIOUS glare from aluminum welding is screened by special goggles recently developed by Dr. R. C. Burt, of the Lockheed Aircraft Company, and technicians of the Corning Glass Works. By analyzing the glare caused by the low temperature at which aluminum melts, the high temperature of the hydrogen torch, and the large amount of flux required in aluminum welding, Dr. Burt found a combination of filters that would stop the undesirable rays. Noninjurious light rays, however, pass through the filters so the welder can see his work, while the flame can be seen at the burner tip only.

new Tools

UNIVERSAL SLOTTING HEAD. Attached in a few minutes to any milling machine, a demountable slotting head provides double-duty facilities at a minimum of cost. The device serves as a vertical slotter and shaper for cutting keyways, templates, splines, and internal gears, and for slotting out precision blanking dies and molds. It operates over a milling-machine table, whose feeds move the work as the slotting proceeds. A 1/3-horsepower motor with four speed changes permits a range of from 50 to 250 strokes a minute. The stroke of the ram may quickly be adjusted from zero to four inches. The illustration at right shows an interesting setup of the tool for cutting a keyway on a compound angle.

TWO-HEAT SOLDERING TOOL. When more than normal heat is wanted, holding down a finger-tip button provides it, in the handy electric soldering tool shown above. It accommodates three sizes of copper tips having the same shank diameter; because of the close relation of shank and heating element, tips larger than the shank diameter can be used. The tool swivels upon its handle for convenience.

DRILL-PRESS GRINDER. Wherever a drill press is available, a new attachment makes short work of grinding plane irons and other bevel-edged tools. Placed in a jig, as below, a straight-edged blade is sharpened by moving it up and down against a grinding wheel attached to the press. Provision also is made for grinding concave bevels. Small objects such as drills may be ground "freehand" with accuracy, since the arrangement makes a convenient hand rest of the drill-press table.

Un-Natural History

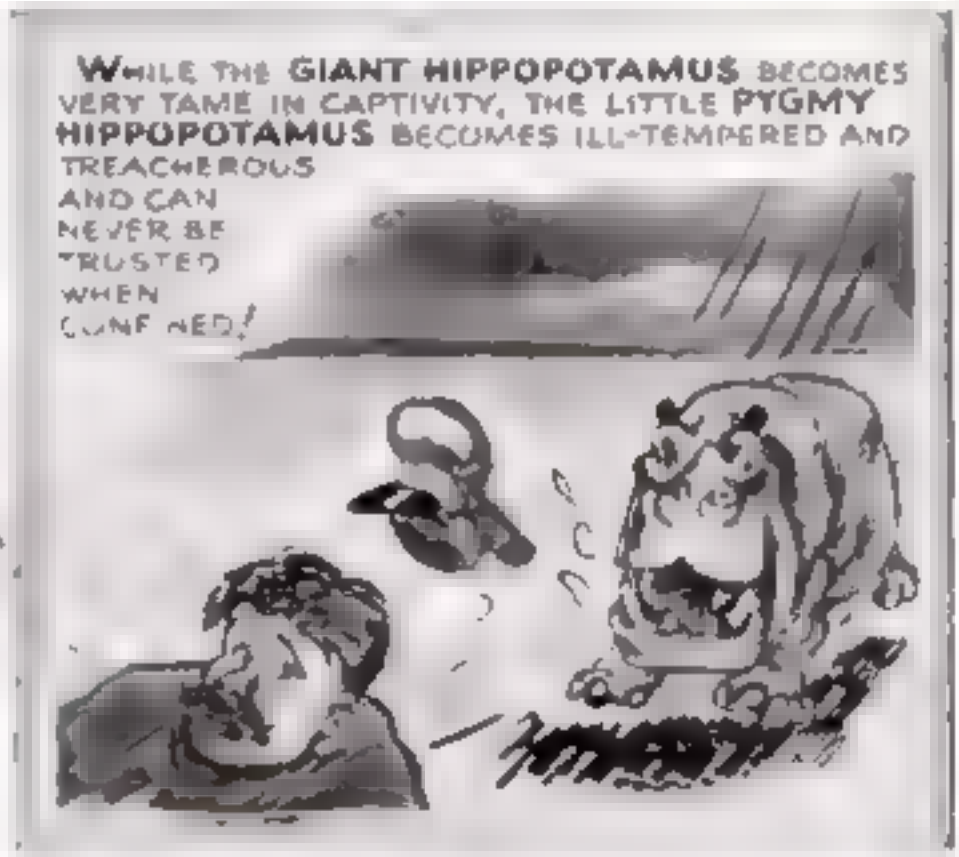
BY Gus Mager

YOUNG **BOWFIN**, A SPECIES OF FISH FOUND IN THE WESTERN AND MIDDLE STATES, MAKE FINE BAIT FOR PICKEREL OR PIKE!. EVEN THOUGH A HOOK IS RUN THROUGH THE MOUTH AND BRAIN, THEY ARE JUST AS LIVELY AFTER BEING CAST 100 TIMES!

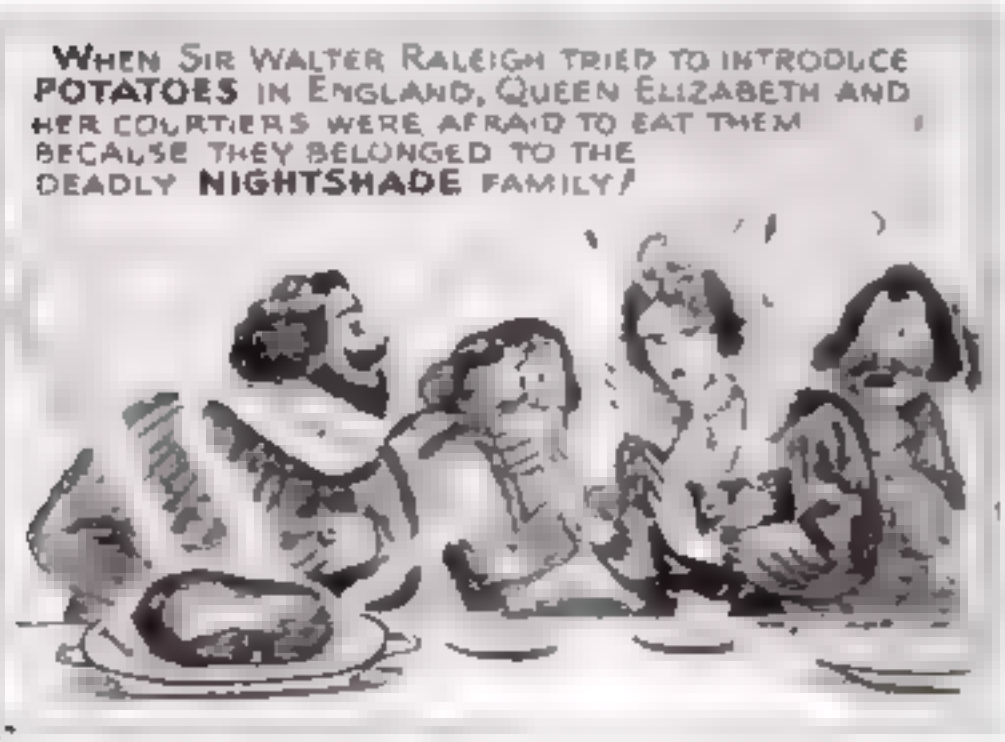
THE **HERCULES** AND **RHINOCEROS BEETLES** OF SOUTH AMERICA ARE SO LARGE AND HEAVY THAT THEY HAVE BEEN KNOWN TO BREAK ELECTRIC-LIGHT BULBS BY CRASHING INTO THEM!

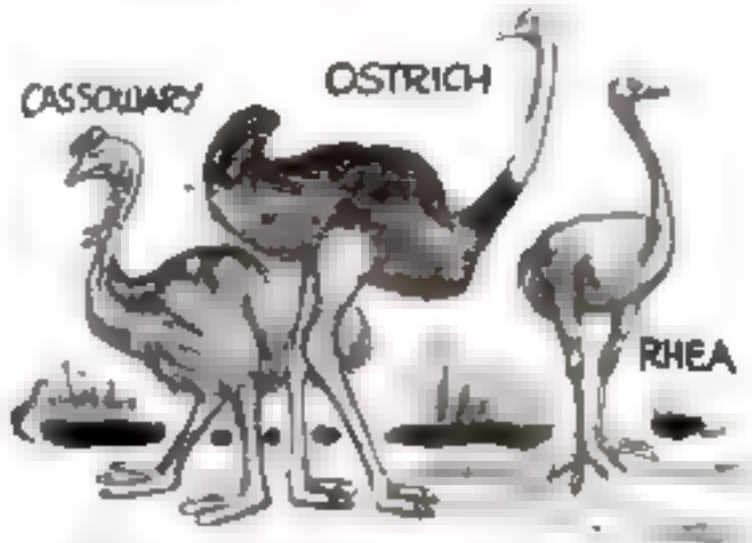
THE STUBBY NECK OF AN **ENGLISH SPARROW** IS MUCH MORE FLEXIBLE THAN THAT OF A **GIRAFFE**! THE GREAT LONG NECK OF A GIRAFFE HAS ONLY SEVEN VERTEBRAE, WHEREAS THE SPARROW'S HAS FOURTEEN!

WHILE THE **GIANT HIPPOPOTAMUS** BECOMES VERY TAME IN CAPTIVITY, THE LITTLE **PYGMY HIPPOPOTAMUS** BECOMES ILL-TEMPERED AND TREACHEROUS AND CAN NEVER BE TRUSTED WHEN CONFINED!



WHEN SIR WALTER RALEIGH TRIED TO INTRODUCE **POTATOES** IN ENGLAND, QUEEN ELIZABETH AND HER COURTIERS WERE AFRAID TO EAT THEM BECAUSE THEY BELONGED TO THE DEADLY **NIGHTSHADE** FAMILY!





TRUE **OSTRICHES** CAN EASILY BE DIFFERENTIATED FROM OTHER RATITE BIRDS BECAUSE THEY HAVE ONLY TWO TOES! **RHEAS**, **CASSOWARIES**, AND **EMUS**, SOMETIMES CALLED OSTRICHES, HAVE THREE TOES!

Sail Making

How Professionals Today Carry on a Craft Centuries Old

WHILE man thrills to sport, the sailboat will hold its own in a modern age, and with it the ancient art of sail making. Today's yachtsman can buy his canvas from the very firm, now in its fifth generation, that made sails for Nelson's *Victory*. Wherever ships and sails are spoken of, the world over, the name of Ratsey and Lapthorn is known. The great lofts of this firm at City Island, New York, where the following pictures were made, and in England, have equipped every challenger and defender in the famous America's Cup Races for the past 83 years.

Aerodynamic formulas compiled long before the Wright brothers flew are used by

the modern sailmaker. Only long experience and training can inform him just how much camber a given sail must be given in order to set well and draw properly. To a large extent each sail is a problem in itself and must be worked out painstakingly as such. But actual sail-making methods are much the same today as when (CONTINUED)

The first step in mak ng a sai is to draw an outline w th chalk on the floor of the off Th s serves as a pattern n cutt ng the canvas which a l comes from one bolt c oth by cloth

In hand sew ng the sailmaker uses a palm n stead of a thimb e Putt ng the metal d sk to the end of the triangu ar shaped need e as be low he can push with the hand s fu st engih

Sewn together carefully, the sail is spread again on the floor and its corners are pegged down with awls. Here the foreman cutter checks his work and excess material, called tablings, is trimmed off

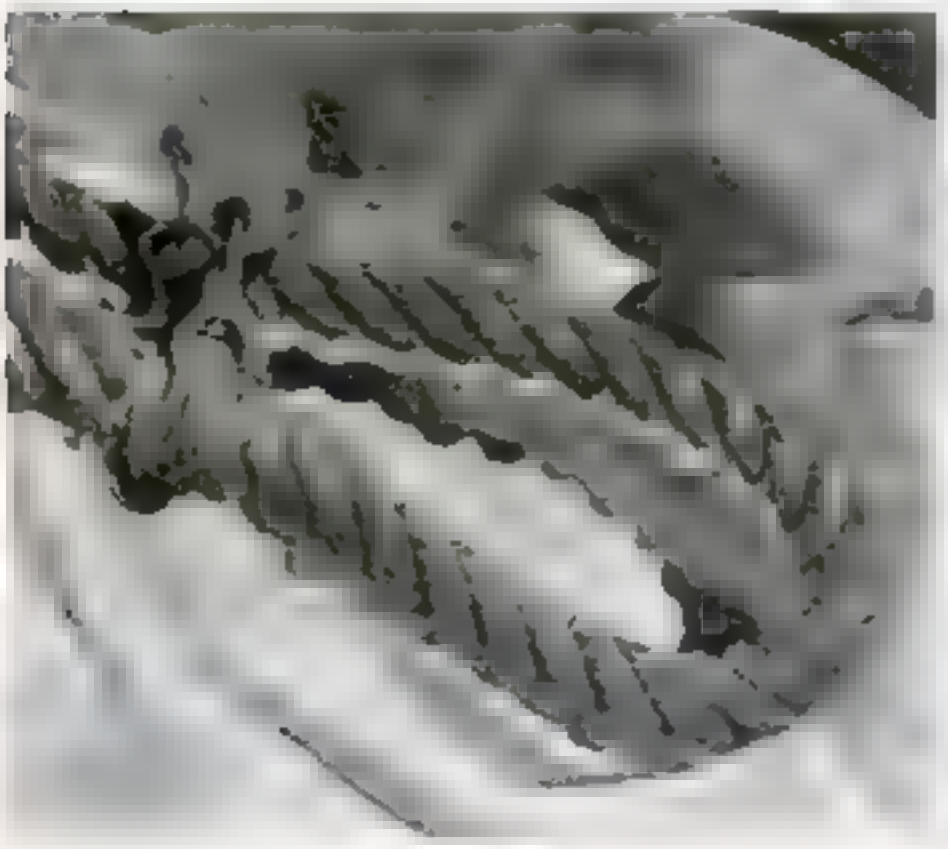
Without his bench hook a sailmaker is as helpless as a steam fitter without a vise. Anchored to the bench with a peg (below), it holds the canvas and leaves his two hands free for the work of sewing

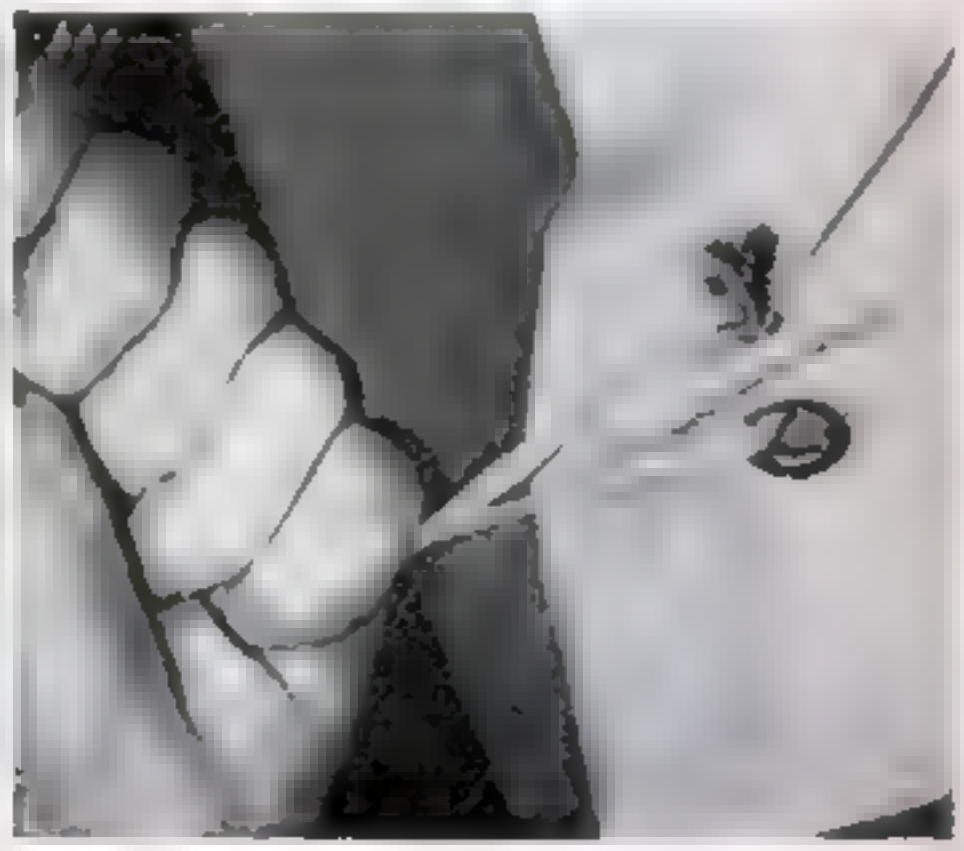
Photos by SAM SCHNEIDER

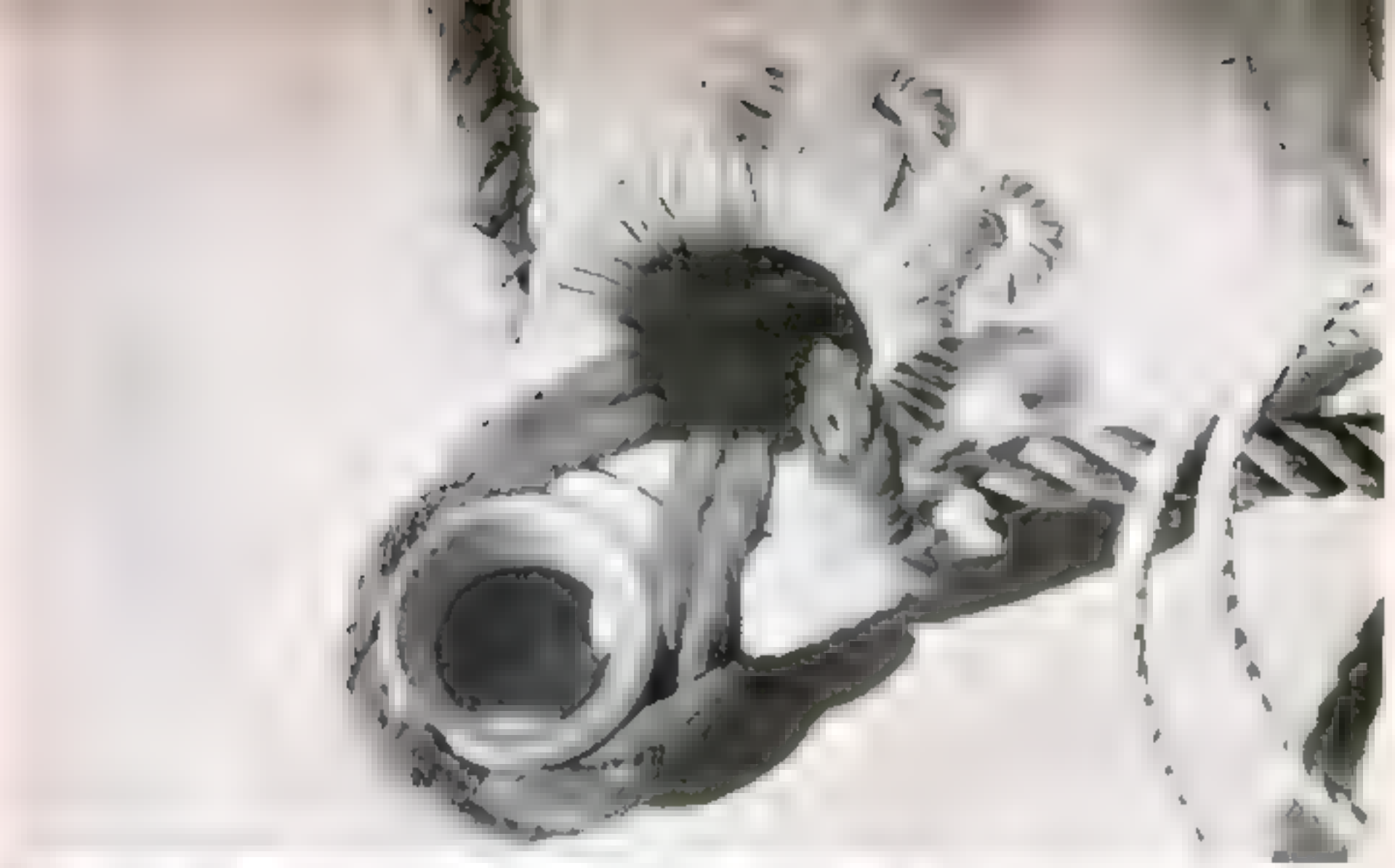
Excess cloth is turned over to strengthen the edge. Trimmed-off tablings also are used for reinforcing the edges of large, heavy sails

Sewing a rope to the sail the heavy waxed twine is slipped between the strands, and not through them The photo below shows the luff rope with a slide seized or toshed onto it

A close up of a sailmaker s palm Below, a simple test shows why a worked ring with brass ring is better for a reef hole than a stamped grommet The grommet pulls out easily, worked ring holds

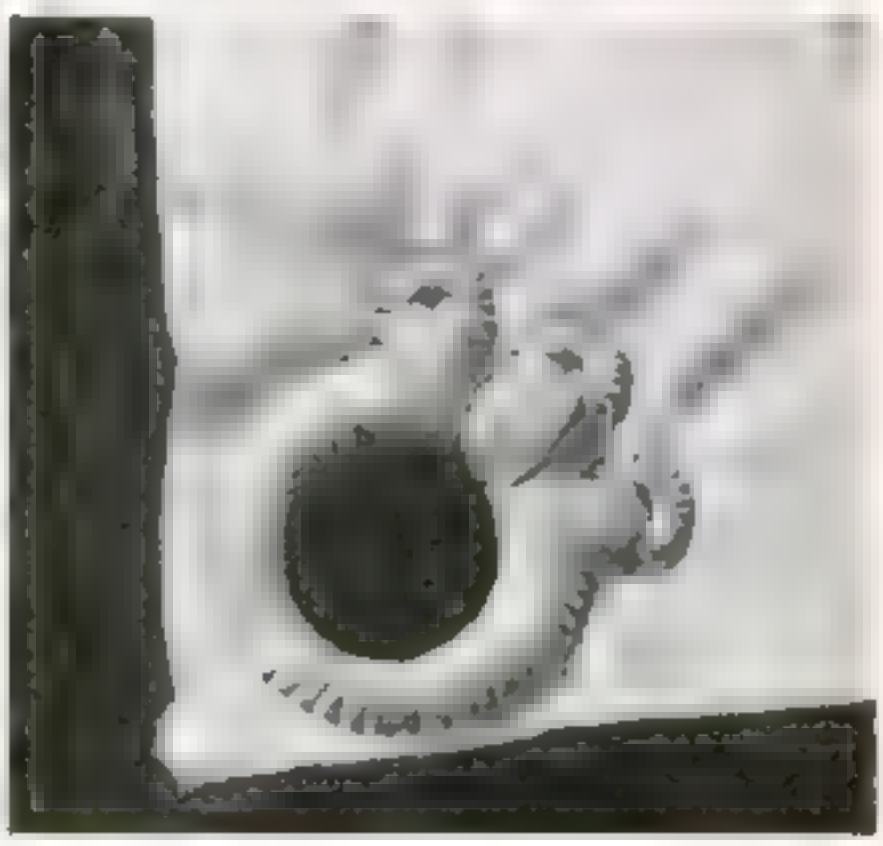


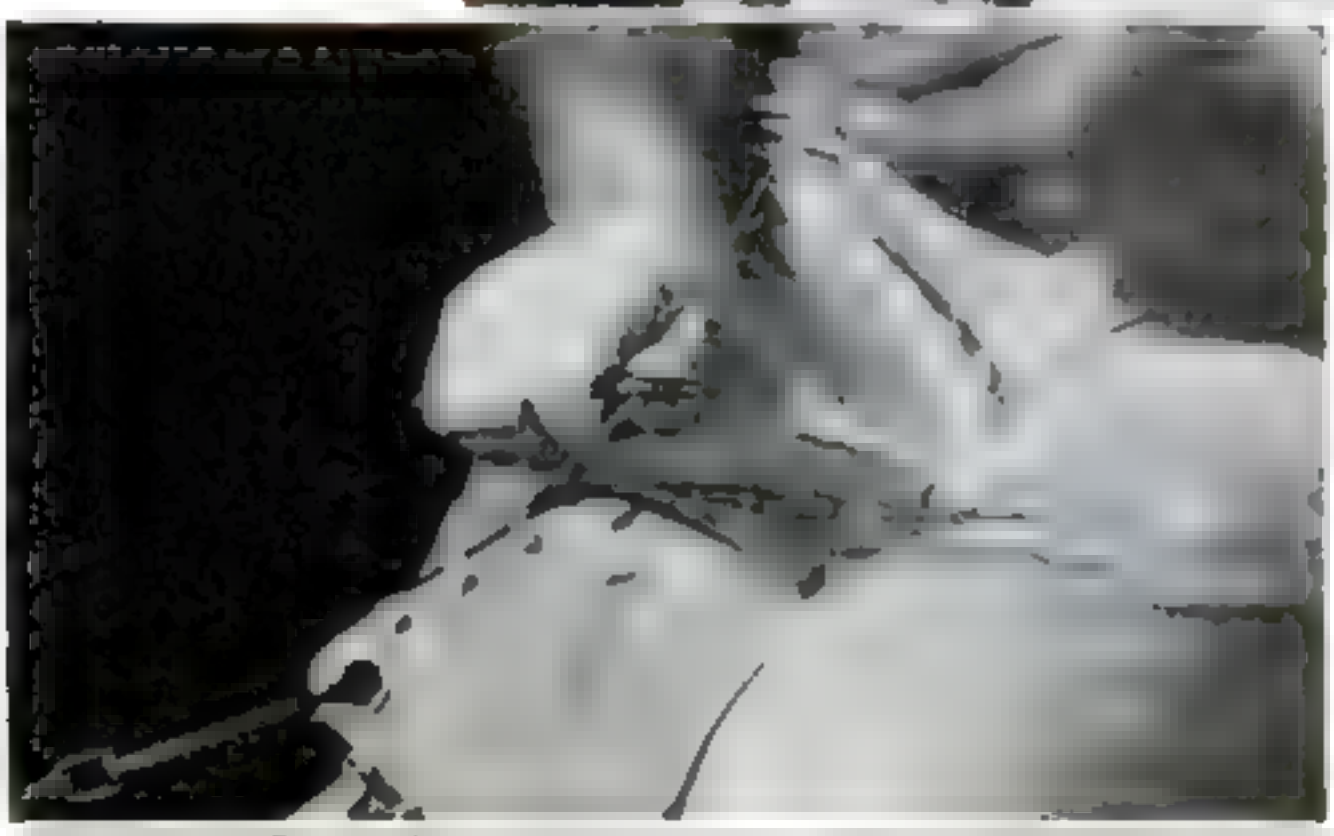




Clew corner for a large boat's mainsail top is made by placing a metal ring between layers of canvas locking it in and then stitching around it as illustrated in the photograph below

Extra strength is provided by rope grommets sewn in around the steel ring below Rope grommets are used here instead of steel to give elasticity The corner now is ready to receive fittings





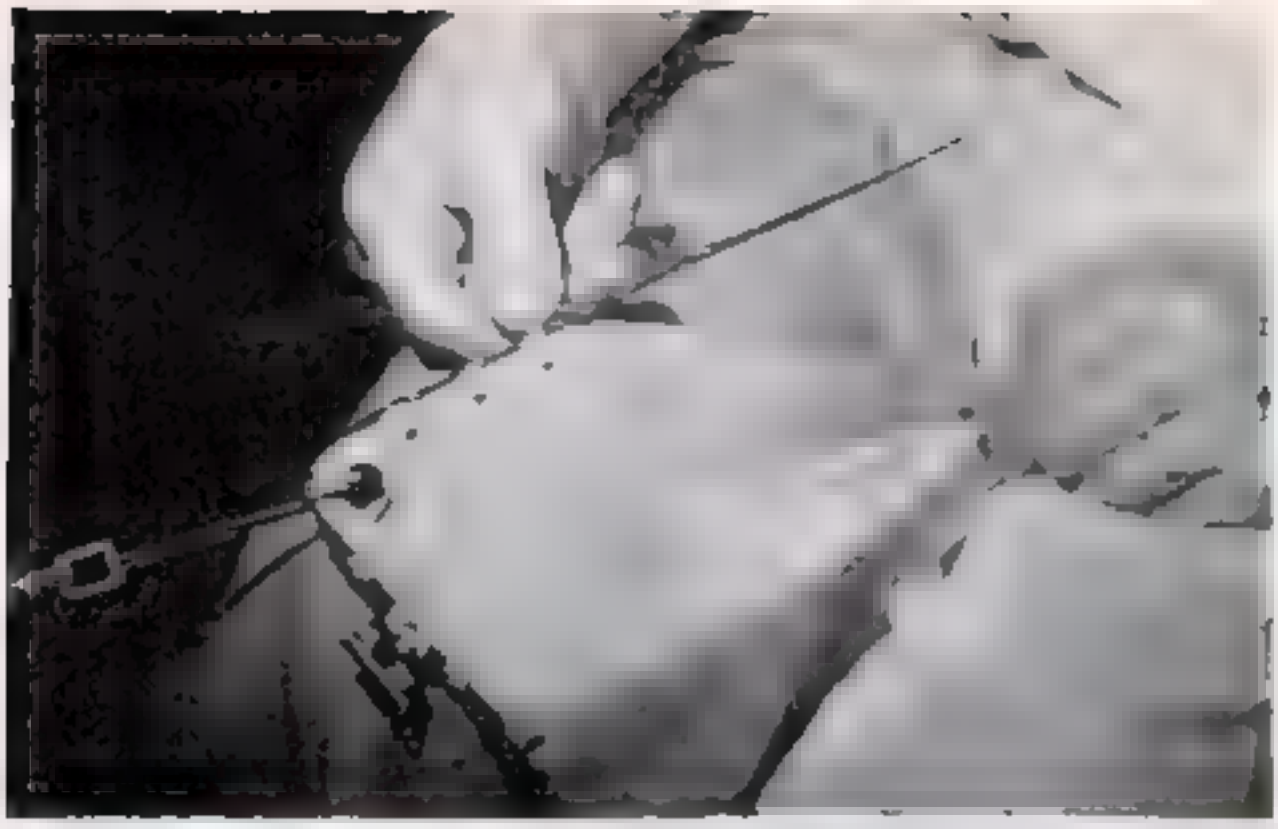
Making a headboard for a Marconi sail: A duralumin triangle is tacked in between patches that strengthen the corner, and rope is sewn around it by means of the grommets shown below

The drawing at the upper left illustrates the use of the "heaver" for seizing rope to canvas. When the twine is wound on this tool, a strong pull is obtained. Above, seizing a slide to the sail

square-riggers roamed the seas

The mainsail of a modern racing yacht may weigh a ton, contain almost a mile of 18"-wide canvas, and eight miles of hand sewing, and cost $10,000. Twenty men may be needed to hoist such a gigantic expanse of cloth aloft. Wind stresses on the sail itself and on its fittings are tremendous—well-nigh incalculable at times. Hence the meticulous workmanship and almost fanatical attention to detail that goes into good sail making. Even today's professional must serve an apprenticeship of five years.

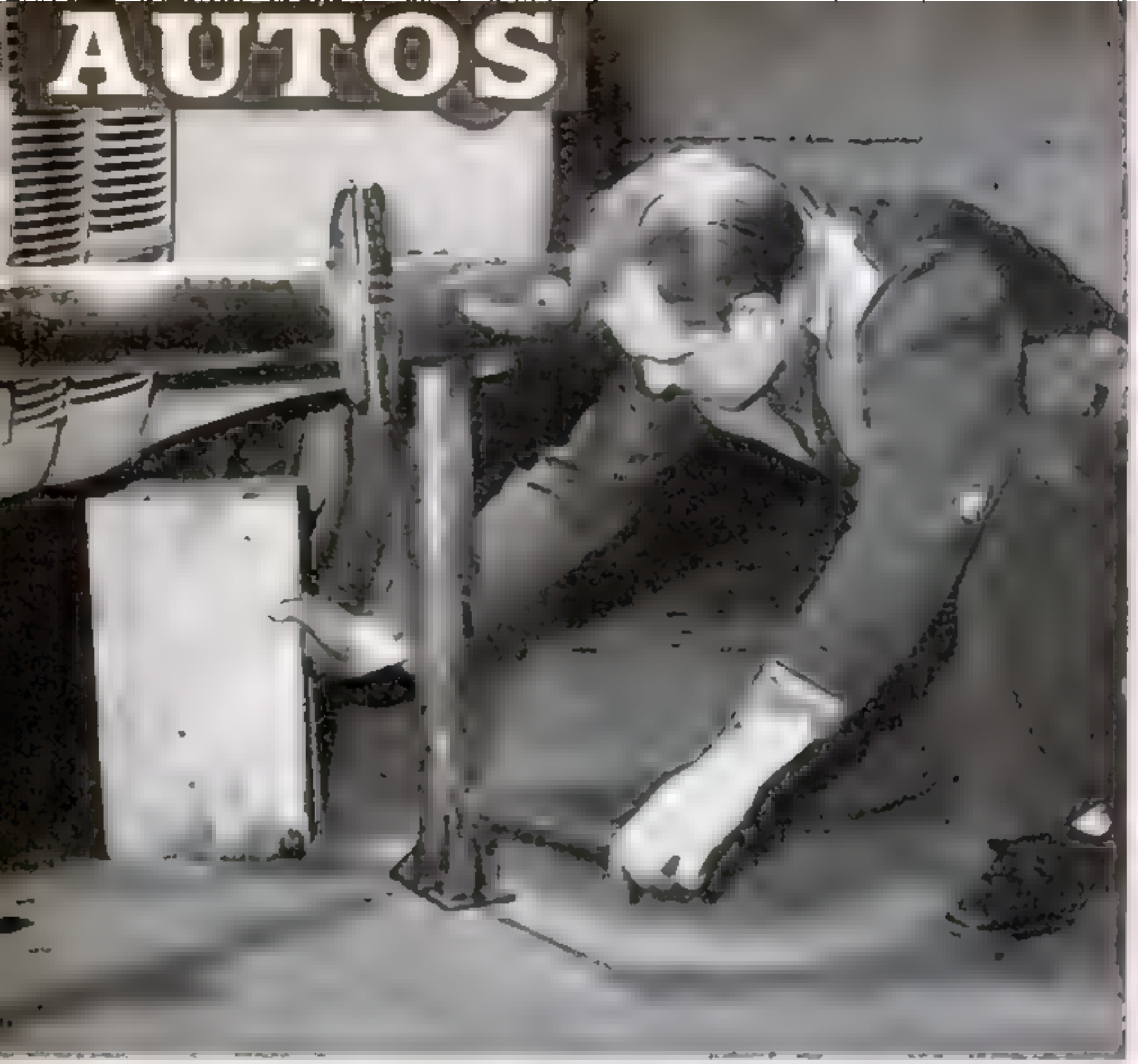
The accompanying photographs show some of the principal steps in making a typical sail.



At top, rope seized to the Marconi headboard is scraped to a point called a rat-tail to make a taper ending. At right, above, is the finished headboard with slide attached as in the drawings

In the photo below, the finished sail is set up for inspection. The Marconi headboard with its seizing and rat-tail is seen at the right of the picture next to the supporting block and tackle

AUTOS



How to Store Your Car

DO THE JOB RIGHT AND IT WILL RUN WHEN YOU WANT IT AGAIN

By SCHUYLER VAN DUYNE

DEAD storage is the name for it. Tire shortage alone, it is estimated, may put millions of cars into the moth-ball retirement of dead storage by the summer of 1943. Gasoline problems may well send millions more

This does not mean that you simply lock up your car in the garage. It would be better to scrap it now. Rather, it means a careful preparation of your car for resistance against two mighty powerful enemies —time and decay. Most cars will be stored in home garages and owners will do the readying themselves. How this should be done, few motorists know.

For example, for the same reason that you oil a fine gun you are putting away, you must oil the valves, valve stems, cylinders, and pistons of an engine that won't be run for a long time. Chrome trim, paint, batteries, cylinder blocks, and upholstery also call for pre-storage care.

The first thing to do is wash your car. Then drive to your service station and have it thoroughly greased. If the engine oil is fresh, it need not be changed, but if it needs changing anyhow, put in a good grade of light engine oil. Next, polish the car from

stem to stern with wax. Now drive it into your garage, remove the ignition key, and say "Amen" to driving

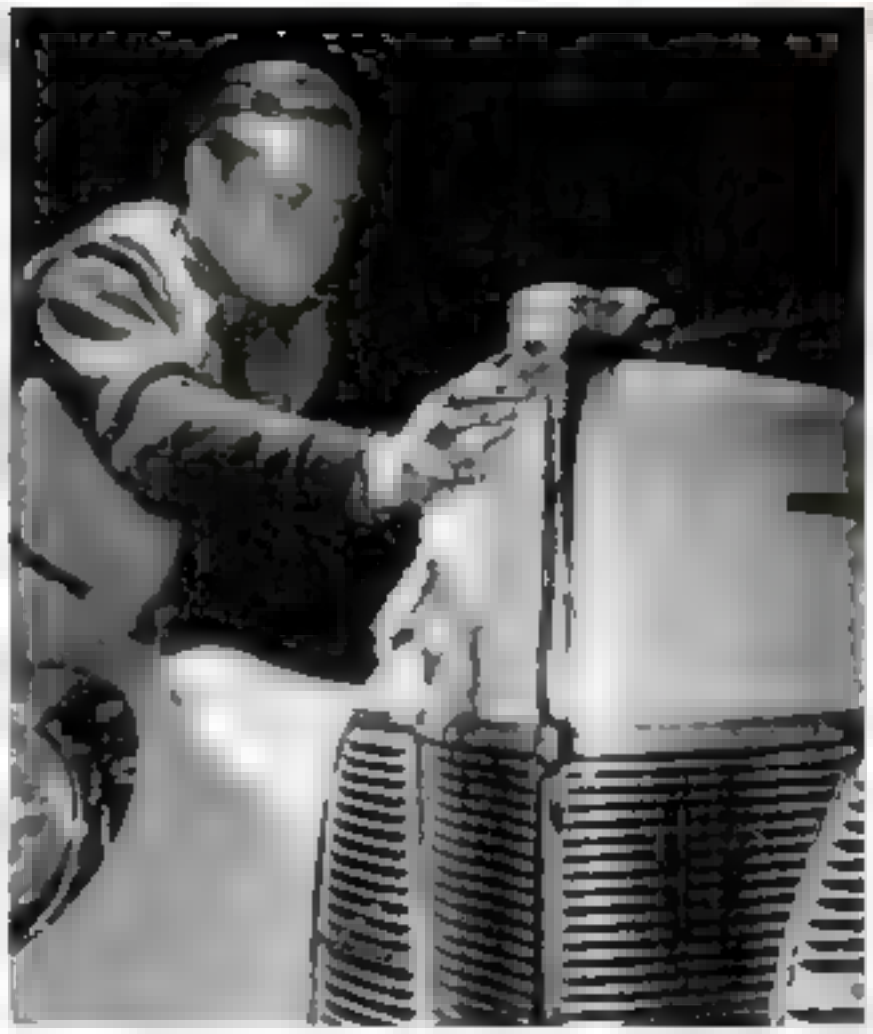
If that was tough for sentimental reasons, the round coming up is going to be tough because it is hard work. It involves getting your engine into shape and begins with draining the cooling system, regardless of the type of antifreeze you use. First, open the radiator drain cock. Next, locate and open the drain at the base of the cooling jacket of the engine block to remove the rest of the liquid

The round has just begun. You must also get every last drop of gasoline out of your car, from the gas tank to the carburetor jets, not overlooking the carburetor's acceleration pump, the main gasoline pump, and connecting pipes. There are two reasons for the gasoline removal, both good. First, any water therein might freeze and split something in winter, or cause rust and corrosion. Second, small quantities of gas left in the carburetor or fuel pump for a long time will first jell like your favorite dessert, then turn into a solid mass like dried paint. When you try to start your car again, it simply won't perk.

To drain the gas, unscrew the plug under the main tank and catch the fluid in pails. Next, remove and empty the gas-pump filter bowl. Disconnect all gas lines at the engine and blow out the main line. Then remove the carburetor completely from the engine, turn it upside down and manipulate the throttle, draining all gas from the bowl and forcing it from the acceleration pump by flipping the throttle lever several times. Put a small quantity of neat's-foot or other nondrying oil in the pump packing. When all gas is out, put each part back as it was. Take every precaution against fire while you are doing this work

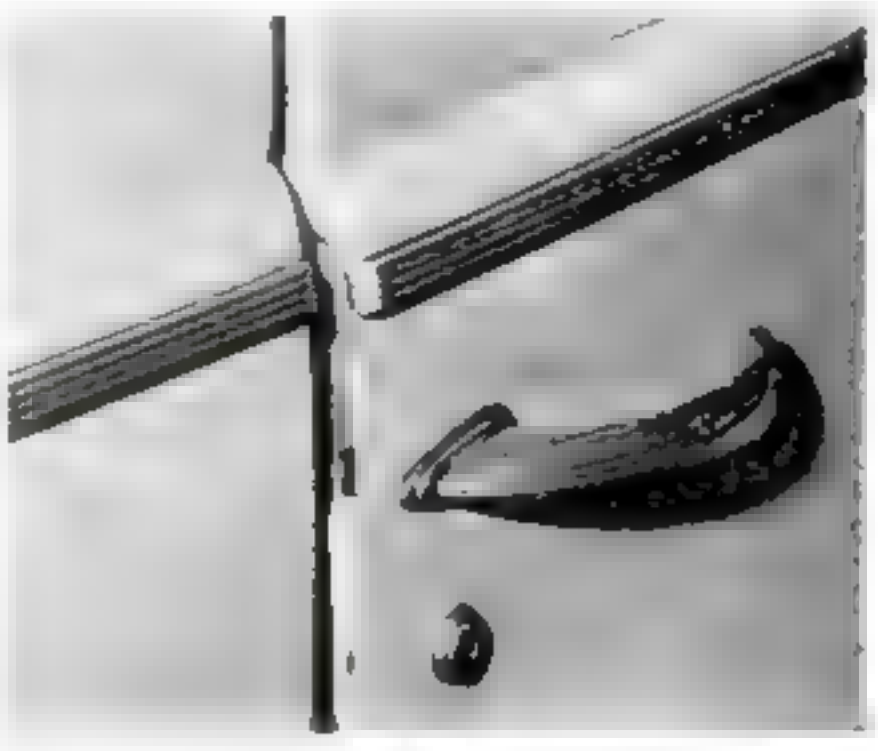
There's one more job on the engine before this toughest round is over. That is lubrication of the cylinders and valves to prevent inevitable moisture from pitting them as it would the unoiled parts of your hunting gun. The most thorough way is to remove the engine head so you can squirt oil through the open valve ports and on the exposed cylinder walls and pistons.

A simpler way is to remove all the spark plugs, rather than the head, and squirt or pour oil through the holes into the cylinders. You should use plenty of oil in each cylinder, rotating the crankshaft short steps at a time by brief touches of the starter button. The oil will spread well around the cylinders by this method, but will not coat the valves and valve stems so effectively A very light engine oil or lard oil should be used. Put back the head or the plugs when the job is done. If the head, consult

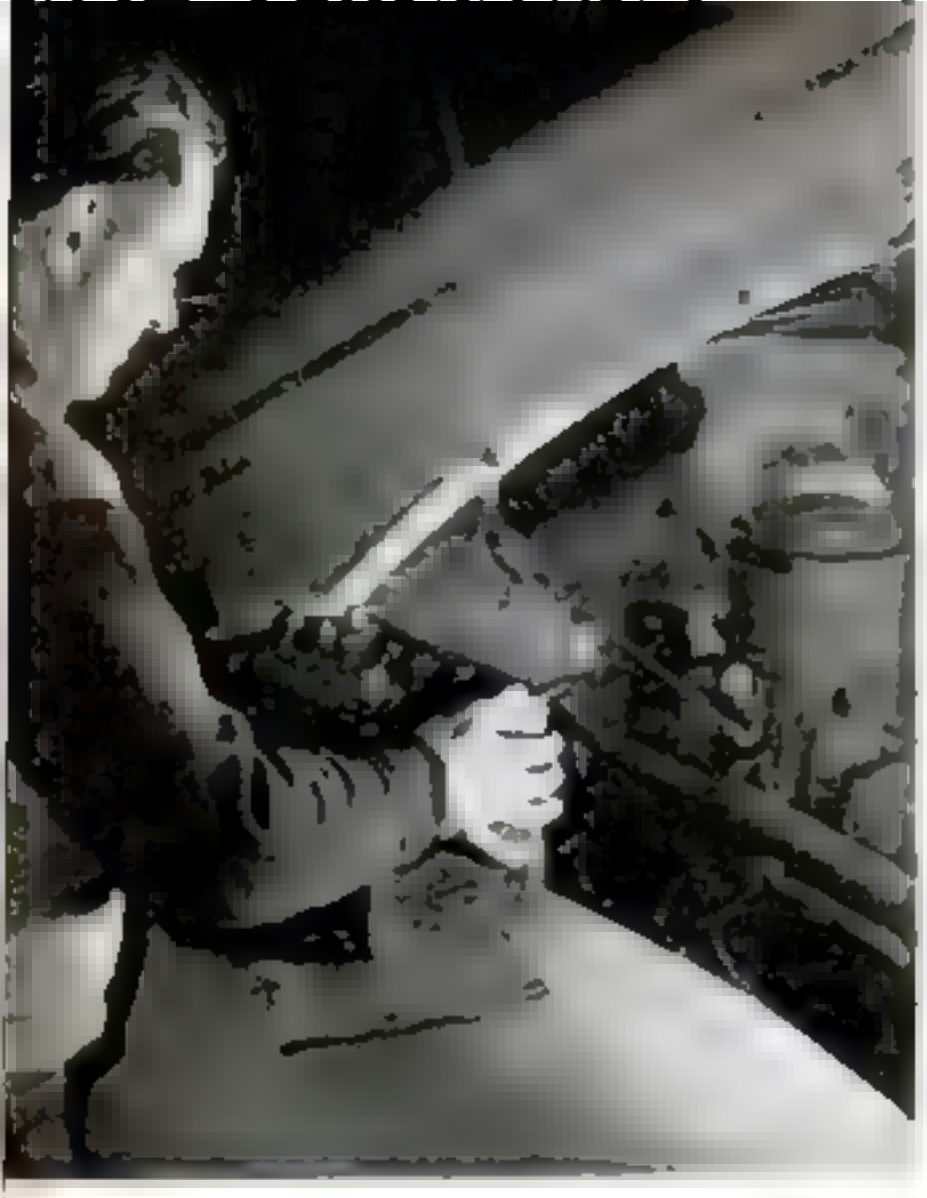


A thorough waxing of the car should follow the first step—washing—toward preparing it for dead storage. There's no better way to preserve the car paint

All chrome plate should get a protective coating of grease or petroleum jelly. If left uncoated, chrome will be attacked and pitted by normal moisture of air



Doors left on the half latch, as shown, will not crush the rubber weatherstripping permanently out of shape. Close windows. Stuff door cracks with paper



The battery must be removed and will require care if you keep it. Out of the car, no one can start the motor, and its acid and fumes will be unable to damage parts of the car

Cylinder walls, valves, valve stems, and pistons should be well oiled. Either remove the head or, as above, the plugs, and turn engine slightly to spread the oil around

your car manual or, if necessary, your dealer, for the proper tightening order and tension of the cylinder-head stud nuts.

Your tough round is now over, though there's still work to be done. You next remove the storage battery completely. If you have a charger, you can keep the battery in shape at home, adding water as needed, occasionally discharging it with four or five 21-candlepower headlight bulbs and recharging promptly. It's a lot simpler to turn it over to your service man to care for. Under no circumstances leave the battery in your car.

A vacuum-cleaning of your car interior will lessen the chances of mold and moth damage, and while you are at your cleaning chores, wipe off all hardware with an oily rag and rub grease or petroleum jelly on the chrome bumpers and trim. Also, wash the battery hanger with a baking-soda solution, then rinse with water, to remove all traces of battery acid. Apply penetrating oil to door hinges and latches taking care not to get any on the rubber weatherstripping of the doors.

Almost the final step is placing your car on blocks to remove weight from the tires, the latter to be left fully inflated on the wheels. Four sturdy supports with wide bases should be made. Ordinary jacks are not sufficiently broad-based to stand up against the shoving of youngsters at play, for example, and serious accidents may be prevented by using safe supports. A good, sturdy homemade support is detailed on the next page, along with safe procedure for getting the car off the floor.

Here you must decide upon the best procedure for storing your tires. Chances are your garage gets hot on summer days, which is bad for tires. Moreover, most garages admit a lot of sunlight through their windows. That also is bad. You may find it advisable to remove the car wheels, including the spare wheel, from the car and store them flat on the cool, dry floor of your basement. Do

Gasoline must be drained from main tank (right), fuel lines, pump, filter bowl, and carburetor. Any left in would evaporate, jell, then harden, thoroughly clogging small openings

not stack them or stand them against a wall, as this would tend to deform the casings.

In any event, since light, heat, and air harm rubber, you are wise to wrap all tires with dark-colored paper and store them in the coolest place available.

Before leaving your car, close all windows, but leave doors on the half latch so that the sponge-rubber weatherstripping will not become permanently squashed. Stuff the door cracks with newspaper to keep out dust. It is a good idea to cover the entire car. Cloth and paper covers made for the purpose are available at many accessory stores. Paper is illegal in some regions, however, because of fire hazard.

Car upholstery may need more than just a vacuum cleaning. Dirt and food spots attract moths, so a careful cleaning with the proper chemical is advisable. Your car manual may recommend what this chemical should be. If it does not, consult your dealer. Before you close up the car for good, sprinkle moth flakes or balls on the seats and cover them with old newspapers.

Fabric tops of open cars should never be folded, but should be left up and covered.

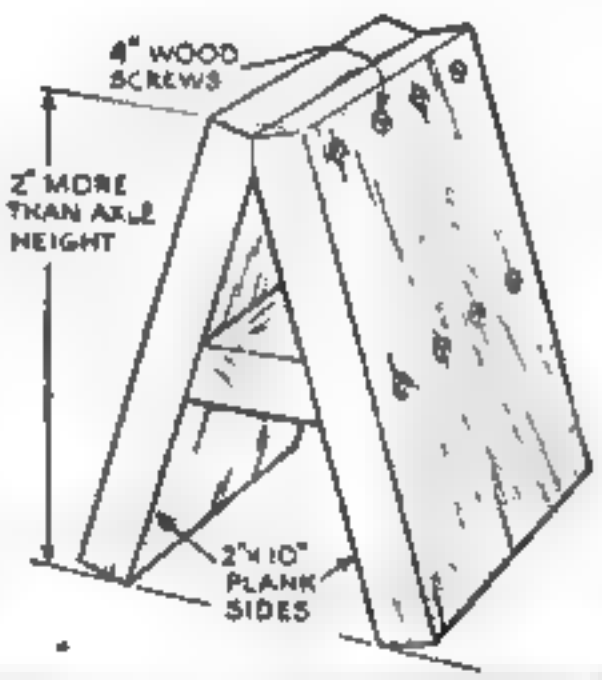
The job of putting your car in dead storage is not easy, you will agree. But make up your mind that if your car is good now, it will not be after two or three years without protection against the assaults of time and decay. It would cost a lot more in money and work to put it back in running condition again than it costs you now to put it, figuratively and literally, in moth balls.

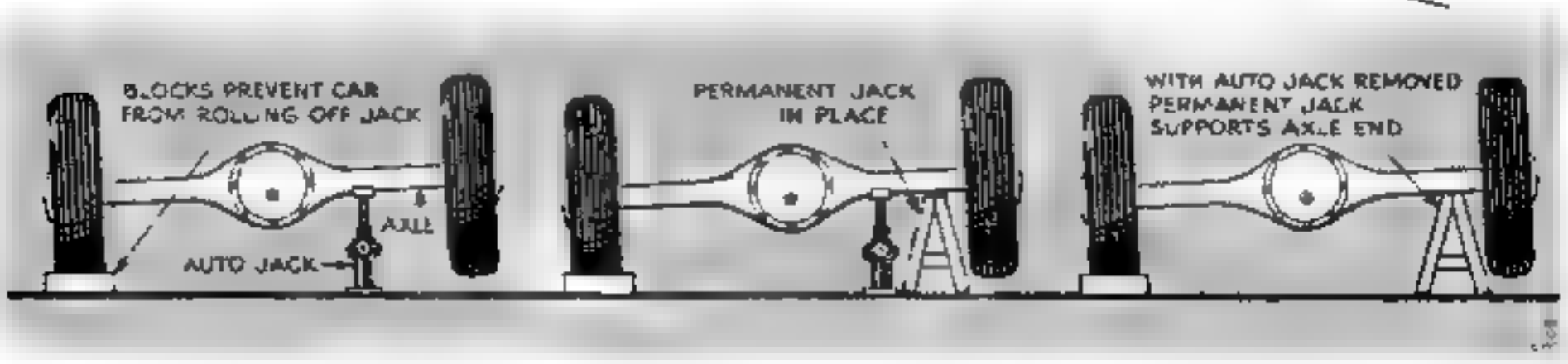
Check Off These Items As You Put Your Car in Storage

1. Wash car thoroughly ☐
2. Change to light engine oil ☐
3. Have car greased ☐
4. Polish body with wax ☐
5. Drain radiator and engine block ☐
6. Drain gasoline tank and fuel pipes around engine ☐
7. Drain fuel filter bowl ☐
8. Remove carburetor, drain the bowl and acceleration pump ☐
9. Apply nondrying oil to acceleration pump packing ☐
10. Blow out main gas line ☐
11. Replace carburetor and lines ☐
12. Remove engine head (or plugs) ☐
13. Squirt nondrying oil down stems of open valves ☐
14. Put oil in each cylinder ☐
15. Turn crankshaft slightly ☐
16. Recil cylinders and remainder of valves ☐
17. Replace head (or plugs) ☐
18. Tighten head studs according to maker's recommended order and tension ☐
19. Remove battery permanently ☐
20. Vacuum-clean interior of car ☐
21. Oil hardware and grease chrome trim ☐
22. Jack up car as detailed below ☐
23. Close all windows ☐
24. Leave doors on half latch ☐
25. Stuff door cracks with paper ☐
26. Cover car if locally legal ☐

THE SAFE WAY TO JACK UP YOUR CAR

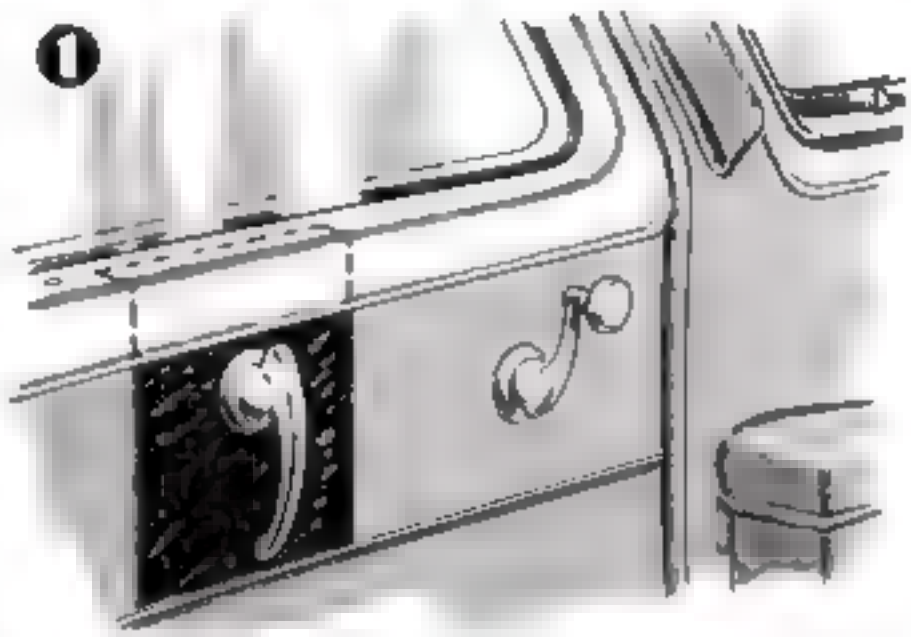
It is highly important to have strong, safe, broad-based supports to hold your car wheels off the floor and prevent accidental tipping if the car is shoved or leaned against while in storage. Four units like the one at right can be made from 2" by 10" planks, screwed, bolted, or nailed with 20-penny nails. They need not be fancy but must be tough. Place blocks before and behind one of the tires of the car as you hand-jack each wheel. On the last wheel to be jacked, use extra caution against upsetting the balance. The jacking-up process is the last step before covering the car body.



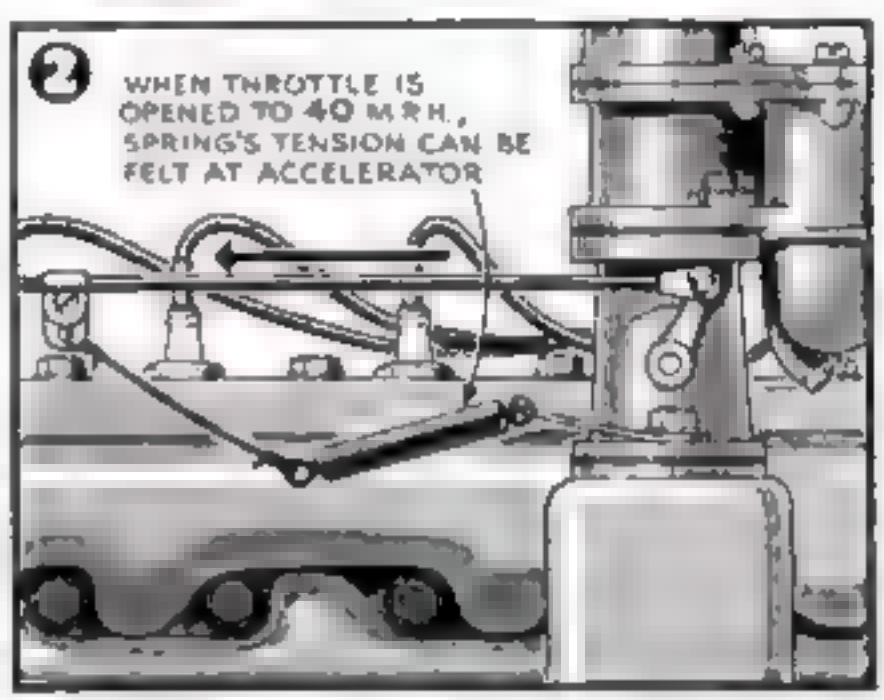


USEFUL AUTO HINTS

1 **NEAT REPAIRS** to the fabric finish of doors, which usually become worn around the inside handles, giving a shabby appearance to the car interior, can be made by removing the handles and gluing squares of artificial leather over the worn portion of the panel. The top should run up under the window molding, and identical patches on each door give a tailored effect.—R.W.K.

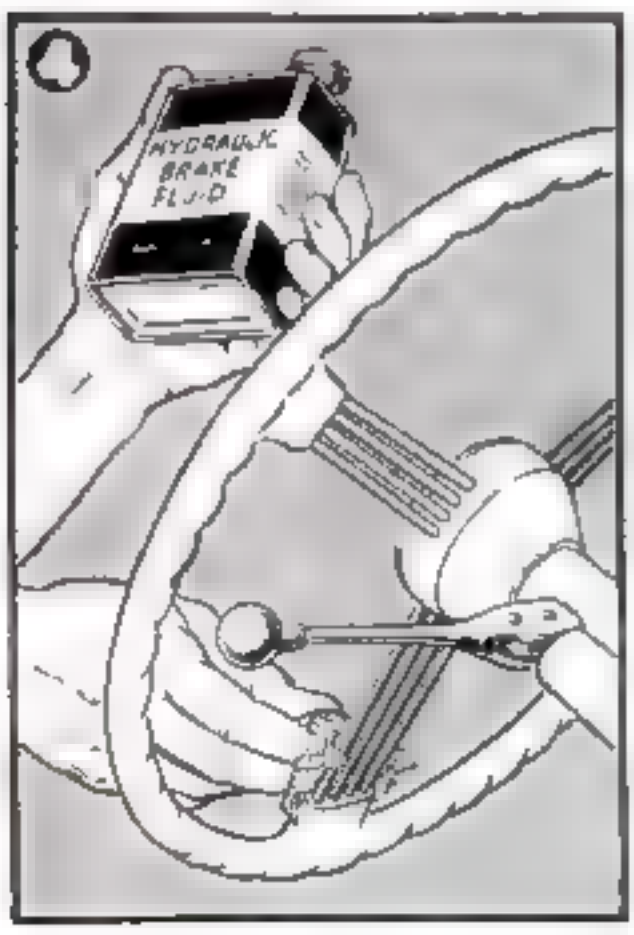


2 **SPRING TENSION,** which can be felt at the foot accelerator when your car reaches 40 miles an hour, will help you keep your speed down to an economical level. The spring is loosely connected as shown, and adjusted by experiment to take effect when car speed reaches 40. It will not hamper the use of full throttle on hills.—H.F.H.

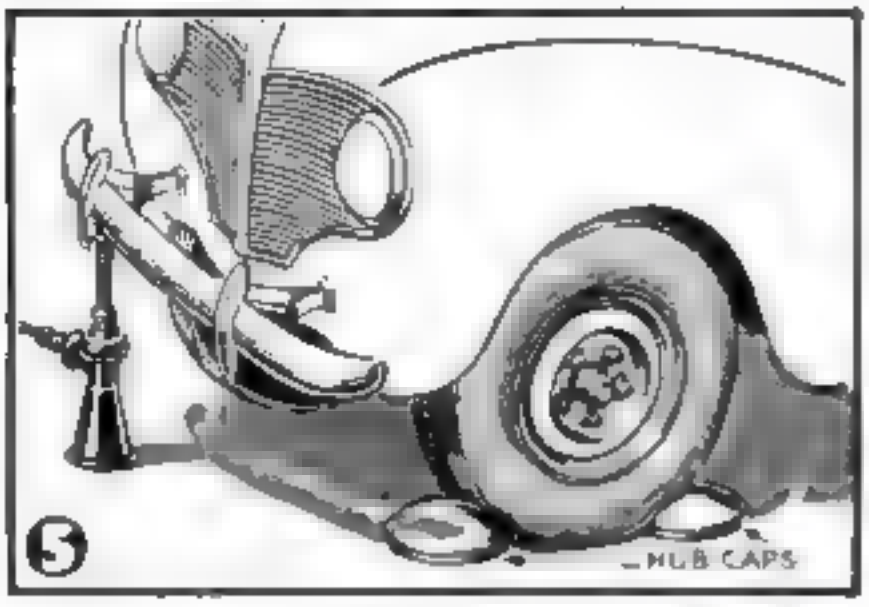


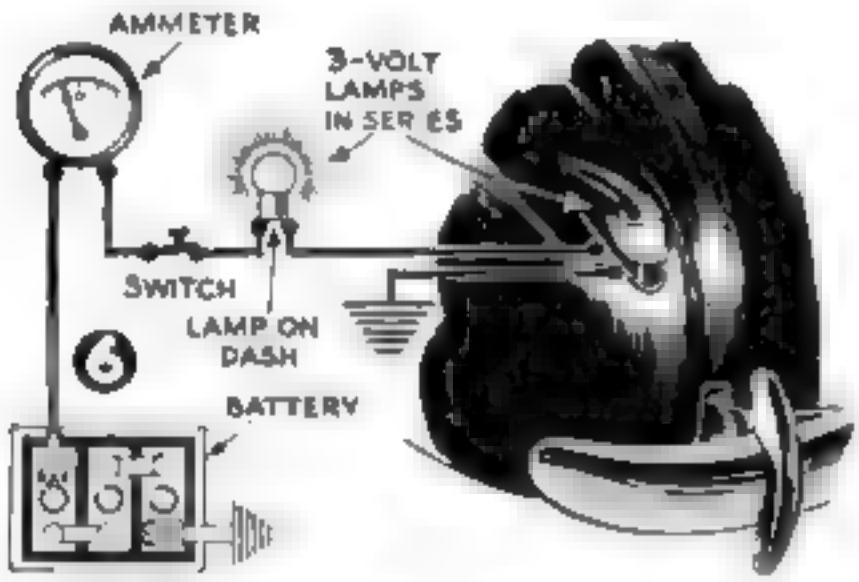
3 **TIRES STUCK TO RIMS** can often be freed with little effort by the simple expedient of placing the wheel on the ground under a bumper and using the car jack to force the bead from the rim. Center the jack under the bumper to take advantage of as much car weight as possible.—J.P.L.P.

4 **SQUEAKY STEERING-WHEEL SPOKES** are a distracting annoyance and sometimes difficult to get rid of. An unusually effective remedy is obtained by rubbing hydraulic-brake fluid on the junction of the spokes and the plastic wheel itself, both at the hub and the rim. Wipe the fluid off again with a clean cloth.—J.R.



FOR BETTER MOTORING

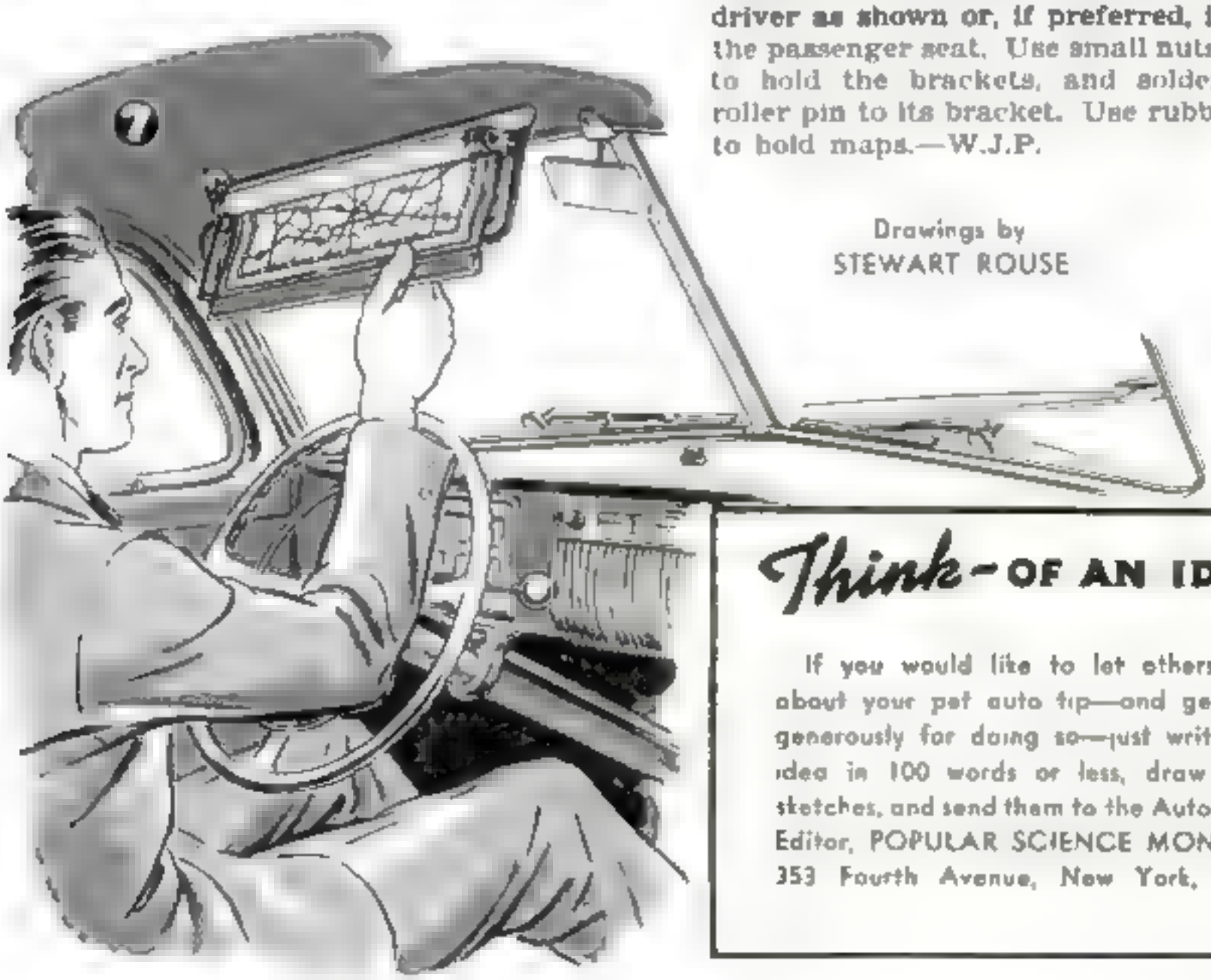




5 WHEEL BLOCKS to prevent the car from rolling backward or forward off its jack while a tire is being changed are handy to most motorists without their realizing it. Such blocks are afforded by the removable hub caps which the majority of cars have. Use one from the wheel that is to be changed and which must be removed anyway. Take the other from the opposite wheel. One before and one behind this wheel will prevent the car from rolling in either direction.—L.R.

6 A NOVEL WARNING LIGHT that tells a motorist if his tail light burns out can be rigged up with little trouble. Mount a small colored lens in your dashboard. Behind this install a lamp socket. Connect the socket in series in the tail-light circuit. Obtain two three-volt bulbs, fitting one into the dash socket, the other into the tail light replacing the six-volt bulb. If the car has twin tail lights, a second, substitute circuit with its own pilot lamp must be run from the switch to the second tail light.—H L.A

7 A HANDY ROAD-MAP HOLDER for drivers keeps its map ready for study. It consists of a cut-down window shade and roller mounted on conventional roller brackets attached to the sun visor either in front of the driver as shown or, if preferred, in front of the passenger seat. Use small nuts and bolts to hold the brackets, and solder the flat roller pin to its bracket. Use rubber cement to hold maps.—W.J.P.



Drawings by
STEWART ROUSE

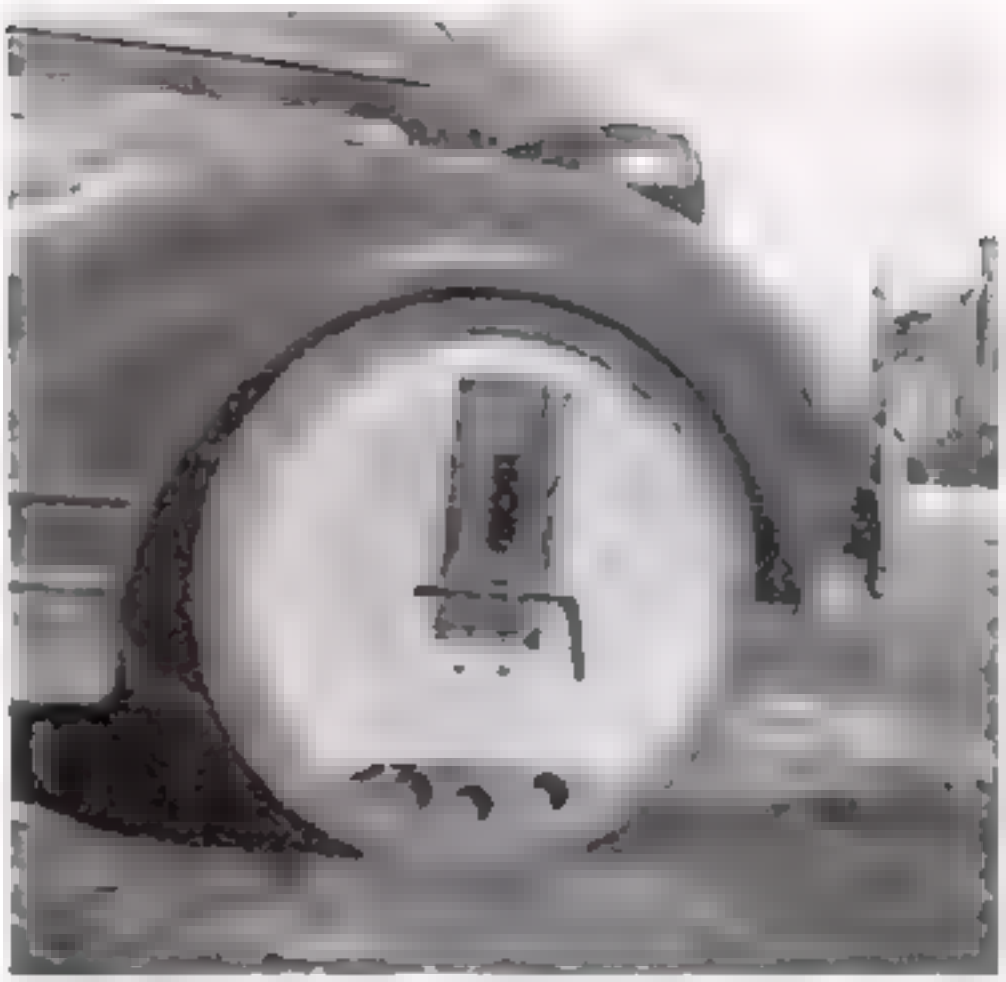
Think—OF AN IDEA!

If you would like to let others know about your pet auto tip—and get paid generously for doing so—just write your idea in 100 words or less, draw rough sketches, and send them to the Automobile Editor, POPULAR SCIENCE MONTHLY 353 Fourth Avenue, New York, N. Y.

EMERGENCY WHEEL SAVES FLAT TIRES

AN EMERGENCY wheel that gets you to a service station despite a flat tire has been devised by Nicholas Z. Grasso, of Hollis, N. Y. It permits driving without injuring a flat tire, is usable on front or rear wheels, and does not interfere with brake action or power.

The wheel is a sturdy metal disk with a solid rubber tire. At its center is a segment with a square hole, which slides on tracks through a limited distance. On getting a flat tire, the motorist removes the emergency wheel from storage beside his spare, removes the hub cap from the wheel with the flat, and fits the square hole of the disk wheel over a permanent, square-ended hub held on the regular wheel by the wheel studs. A special pin holds the wheel on the hub. As the car starts, the first half turn of the eccentric emergency wheel raises the flat tire, then centers the emergency wheel on the hub and automatically locks it there. Thereafter the emergency wheel becomes a working wheel of the car. While the wheel with the flat continues to turn, its tire is held safely off the pavement.



Behind this emergency disk wheel is a regular wheel with a flat tire. The car will run perfectly on it

How it is used: The thin emergency wheel is removed from the trunk where it is stored with the spare . . .

. . . and the hub cap is taken off wheel with the flat. Note the square-ended hub held on by wheel studs

Square hole in sliding panel of emergency wheel is fitted over square-ended hub. When locked on . . .

. . . the car is ready to roll again. First half turn of wheel lifts flat and centers emergency wheel (top)

Gus . . . figures out a gilhickie

But, Seriously, He Also Tells How Garage Men Can Help Win the War by Sending Old Valves to Uncle Sam. Just Where—and Why—You'll Find Out From Him

By MARTIN BUNN

'These old valves have a job to do," Gus told the doctor. "They've got to help win the war. I've just picked them out so they can do it."

STOPPING at the Model Garage late one afternoon for a chat with his friend Gus Wilson, Dr. Marvin found him pawing over an accumulation of old valves that he had spread out on his workbench. Gus grinned at his visitor, grunted a greeting, and went on examining the valves. The doctor started doing the same thing. But after he had picked up a few valves, looked at them, and put them down again, he turned to Gus.

"Why are you fooling with this junk, Gus?" he wanted to know. "There isn't a valve here that even you can do anything with. Some of them are burned, some are badly warped, some are hopelessly pitted, and not one of them is worth a darn."

"Sure I know it, Doc," Gus agreed placidly. "But these old valves have a job to do. They've got to help win the war."

"Huh?" the doctor asked.

"They've got to help win the war,"

Gus repeated. "I've just picked them out of my scrap box so that they can do it. You remember Harry, don't you, Doc—our old grease monkey? He was with us three or four years, and before he went into the Army he had developed into the best all-around mechanic we've ever had in the shop—that is, when he didn't have some girl on his mind so bad that he couldn't think of anything else. Well, Harry's a lieutenant in the Armored Force now. He's stationed at the Armored Force School down at Fort Knox, where they teach the boys how to keep tanks rolling. I had a letter from him this morning—here it is."

Gus fished the letter out of his workbench drawer. "It's mostly about some girl down in Louisville he thinks he wants to marry," he explained with a grin, "but while he was writing it he had a lucid interval, and he said—here it is: 'We've got some swell valve-refacing units here at the School, but we can't get hold of enough old valves for the boys to work on, so they have to do their practicing on new valves, which is a waste of good valves and not nearly as good practice. Say, Gus, why don't you dig through that old junk box under your workbench and pick out all those no-good old valves you've been hoarding for years and send them down here where they'll do some good? Any size will do. Address them to the Commandant, Armored Force School, Fort Knox, Kentucky, and don't mention my name or the General will think I'm trying to run the School for him. You'll have to pay the parcel post on them, but that won't break you. Say, Gus, I've met a lot of swell girls since I've been in the Army, but this one is . . . ' "

Gus put the letter down. "He's off about that fool girl again," he said disgustedly. "But that's a good idea of his about old valves. I'm going to pack up all I can find and send them down there. I've phoned a couple of shops, and they're going to send their old valves over to me," Gus told him. "We ought to be able to get a boxful together. Everyone wants to help, and—"

He broke off as a voice said loudly: "Hello, there, Gus—my car ready?" and looking up saw Ez Zacharias, his R.F.D. cap on the back of his shaggy head, standing in the open shop door.

"All ready, Ez," Gus told him. "It's on the greasing rack. Wait a minute and I'll get it off for you."

"Never mind—I'll get it," Ez said gruffly. Gus saw him climb into his car and then didn't pay any more attention to him. But after half a minute he heard the big postman's voice raised in wrath. "What the heck have you done with this crate?" Ez yelled. "It won't start. When I step on her all I get is a sputter. . . . Hey! Come on over here! Somethin's burnin' under the hood! Hurry up!"

Gus was at the greasing rack in a flash, and Dr. Marvin wasn't more than a step behind him. They could smell something burning, and a faint wisp of blue smoke was spiraling ceilingward from the car's front end. Gus jerked up the hood and made a swift examination, but he couldn't locate the source of the smoke.

"Very little trouble with them, Doc," Gus said. "But, of course, their parts are bound to wear out, same as everything on a car."

"Try her again," he directed. Ez stepped on the starter, but the engine wouldn't take off. "Pump on the accelerator a few times," Gus told him. Ez pumped. "Now step on the starter again," Gus said. "No good, hey? All right. I think I know what's the matter. Release your brakes, Ez. We'll push her down to the floor so I can get a good look at her."

Gus and Dr. Marvin shoved her back, then Gus took another look under the hood. "Thought so," he said after a minute or so. "Your automatic choke has gone wrong somehow." He stuck his head under the

hood and sniffed. "Yep—that's where the smoke came from. Know anything about automatic chokes, Ez?"

"Who, me?" Ez said defensively. "No, nothin' except that if you got one on your car you don't have to pull out the choke to get started on a cold mornin', the way you used to."

"How about you, Doc?" Gus asked.

"I'm afraid that I don't know anything more about them than Ez does," Dr. Marvin admitted.

"Well, you're going to now," Gus told them. "Let's see, now—"

He removed the automatic choke and started to disassemble it. "There are four or five different makes of automatic chokes in common use," he said, "and each one works a little differently from the others, although the idea of them all is the same—to supply the engine with a rich mixture for starting, and then to automatically lean the mixture as the engine gets warmed up. On this particular model the choke is worked by an electromagnet that is connected with the battery when the starter is on. The device has a coil made of enamel-insulated wire and is inclosed in this metal shield. Let's see, now—yes, here it is!"

Gus pointed to a small piece of fiber that extended from the shield. The fiber had broken, and a sizable piece of it was missing. "This is the cause of the trouble, of course—this broken fiber," Gus told them. "The fiber insulates the enameled wires from the metal shield. When that piece of fiber broke off the wire came in contact with the metal, shorted, and burned through. That's where the smoke came from."

"Yeah?" Ez said disinterestedly. "Well—so what? What I want is to get home to my supper—I'm hungrier than a bear. How long is it goin' to take you to fix this-here gilhickie so my car'll start? That's what I want to know."

"Ten minutes—maybe only nine if you don't pester me too much while I'm doing it," Gus told him. He went over to his workbench, rummaged through one of its drawers, and came back with a short length of tubular insulation. Unwrapping a turn of wire from the magnet, he slipped the insulation over it, and then connected the wire to the lead from the starter. Then he replaced the choke on the carburetor. "Try her now," he said.

Ez stepped on the starter. The engine took off instantly and ran smoothly. Gus closed the hood, and pointed to the door. "On your way!" he said.

"How about the automatic choke on my car—does it work the same way as the one on Ez's?" Dr. Marvin asked after the grinning postman had driven out of the shop.

Gus scratched his ear as he did a little thinking. "No," he said after a few seconds, "it doesn't. The one on your car has a thermostatic spring that holds a piston at the top of its travel as long as the engine is cold. That keeps the choke valve closed and supplies the engine with a rich mixture for starting. Slots in the choke piston allow the vacuum of the intake manifold to draw air from near the exhaust manifold into the intake manifold. As the air grows warm, it heats the thermostatic spring. That decreases the spring's tension and gradually opens the choke and leans the mixture. That's a sort of rough blueprint, Doc, but maybe it'll give you an idea of how your choke works."

Dr. Marvin nodded. "It does," he said. "Do you have much trouble with these automatic chokes, Gus?"

"Very little trouble with them, Doc," Gus said. "They're pretty foolproof. But, of course, their parts are bound to wear out sooner or later, same as almost everything else on a car.

"The trouble I've run into most often is the choke's air-cleaner screen being badly clogged up with dirt. When that happens the flow of warm air from the manifold is cut down and the choke doesn't open fully. A tip-off on this condition is a sort of loping idle with a warm engine. That's easy enough to fix. All you have to do is wash the screen with gasoline and then blow it out with compressed air. That should be done every 5,000 miles or so.

"Air leaks cause grief now and then, and sometimes the cause isn't easy to find. Sometimes you run into a leak in the choke suction-tube gasket, which decreases the action of the manifold vacuum on the choke piston. The result of that is that the choke doesn't open all the way when the engine is running at low speeds, and gasoline is wasted. A new gasket is the only answer. *(Continued on page 207)*

GUS SAYS:

Don't keep gunning your engine while waiting for traffic lights. Each time you step on the foot accelerator it shoots about a thimbleful of extra gas into the carburetor to prevent misfiring. So you'll save a lot of gas by not doing a jig on the pedal.

Lights! Camera! Action! Actors in place, filming begins under the guidance of the director. This amateur movie club's backstage personnel looks after details with the same care used on professional lots

HOW TO MAKE

Civilian-Defense Movies

By Andrew R. Boone

AMATEUR movie makers from coast to coast can now turn their talents and equipment to the important task of shooting civilian-defense films. There is a widespread need for these pictures. They serve two purposes: they boost morale at a time when most of our activities are turned toward production and training for war, and they instruct civilians in activities that will help preserve property and save lives.

In nearly every community one or more organizations are working in the defense program. Your local organizations are a natural source of ideas for pictures. Federal authorities also have provided instruction on various subjects, from the fighting of incendiary bombs to the duties of air-raid wardens. Both sources may be tapped in the creation of interesting and instructive films.

A word of warning here will prevent disappointment later. Instructional films should be attempted only with the approval of national, state, and local authorities. These people know what types of pictures are needed, what you should and should not show, and how your subject should be presented

A concrete and valuable suggestion on this last phase of your problem is made by Warren Scott, director of the school of cinematography at the University of Southern California, who recently completed two educational features with Federal sanction.

"It's a good idea," he says, "to try the newsreel approach—and a well-organized club is just the sort of group to do that. Start by creating a production committee. Each member will contact one civilian-defense organization regularly and learn what has been done that might make a picture. Following these reports, production units of two or three persons will visit the various groups, each unit shooting one phase of the 'newsreel' issue. Finally, a board of editors will cut and assemble the scenes."

TIPS ON SHOOTING DEFENSE MOVIES

Check facts carefully to make your picture authentic.

Shoot only with official help.

Have enough money available to insure completion.

Attempt only pictures you are technically qualified to make.

Use local people both behind and in front of the camera.

Forget individual credit; this is a defense activity.

Give everybody in the club a job.

Fix a schedule; then stick to it.

Show the pictures in schools, churches, and theaters often enough to give everyone a chance to see them.

Before making any scenes of handling an actual thermite bomb, director and actress go over the script with a city fireman and an expert representative of the local Office of Civilian Defense

WHAT YOU CAN DO FOR VICTORY

For sequences showing an actress chopping a hole through a roof to get at an attic blaze, club members built this set, which consists simply of a box. The cameras shoot from several angles simultaneously

Nor is such a program to be thought of as a formidable job. It can be fun, and the resulting films will be interesting not only now, but long after the war has ended. You are really recording local history on celluloid. Perhaps a single scene will commemorate the salvage drive this month, and another the fire-prevention campaign. As a climax, you might devote 4 or 5 minutes of the film's running time to the "best job" of the month. Maybe this time it is the women's ambulance service; next month it may be the Boy Scouts' wastepaper drive. But don't make the mistake of awarding honors to the same group twice in succession.

Get everyone in the club working on this program. If all are planning and working and shooting, your group is more likely to cover all worth-while subjects adequately There are plenty of subjects to keep everybody busy—simply work with the fire and police chiefs of your town, get the necessary permits from any military organizations in the neighborhood—and shoot. However, be sure you don't film anything of a vital military nature.

It makes no difference whether you shoot on 16-mm. or 8-mm. film, or with or without sound. Color, properly exposed, will of course give a more pleasing and true-to-life picture. Normally, 600' are adequate for 16-mm. and 400' for 8-mm. reels. The pictures may be shown in lodges, schools, churches, and theaters. If you do not wish to pay the price of sound recording, why not try the method evolved by Raymond Cowley, a teacher in Phoenix, Ariz.? Each week, Cowley shows at a Phoenix theater a 400' 16-mm. newsreel of local events. As his 16-mm. projector throws the picture on the screen, he delivers his narration in person into the public-address system.

Maintain the prestige of your club by making films at regular intervals. You'll have far more fun and contribute more to your own community's welfare if you pre-

sent the story of home-town activities instead of going far afield. Whether you shoot newsreels dealing with several subjects, or feature films covering only one subject each, make them strictly local productions—that is, use home-town actors or civilian-defense workers, and co-operate with defense agencies such as army posts, the police and fire departments, the Red Cross, and other groups engaged in protecting your lives, health, and property.

Make your pictures for the folks in your own community; don't expect your films to tour the nation as epic contributions to defense. Uncle Sam will soon be distributing professionally made pictures dealing with subjects the Office of Civilian Defense thinks everyone should see.

One of the first amateur-made defense films was completed recently by the alert Cinema Club of Long Beach, Calif. Its film shows how to combat incendiary bombs.

To begin, President Robin Hauley appointed a special committee to guide the

With a fire-prevention expert guiding every step, rehearsals are held. Precautions must be taken not to damage the building badly or injure the actress

Ready to begin the scene, the fire-department expert ignites the bomb, using a slow-burning fuse. Only a fireman should tackle this job

Then the fireman moves swiftly, touching a match to a curtain to add realism. Another fireman stands by with an extinguisher to help should he be needed

And here is the actual scene as it is filmed. Having been expertly coached, the actress puts sand on the bomb, using a long-handled shovel

club's defense activities. This committee contacted both local and regional defense authorities to determine what type of picture would best serve that locality. Because Long Beach lies within a "combat zone," it was decided that the fighting of incendiary bombs would be a desirable subject.

Next, the committee won the approval of the local defense council. The fire department checked the script, provided a condemned bungalow where the fire scenes might be filmed, supplied magnesium, thermite, a dummy bomb and a real one, a pumper to stand by while fire sequences were shot, and the chief of the fire-prevention bureau to give expert instruction.

Three "sets" were arranged. These were the interior of a downtown beauty parlor, a specially constructed roof and attic, and the condemned house. Club members built the "attic" on a vacant lot.

With club equipment pooled, the members swung into action, completing the picture on 16-mm. Kodachrome in three week ends. The production required 65 scenes on 600' of film, and was released both silent and with offstage narration. To provide for sound, it was shot at a speed of 24 frames a second.

The picture provides a fine example of how any defense subject may be treated. It opens with a burning title superimposed on an incendiary bomb. From this, the viewpoint shifts to the beauty parlor, where several women are talking about fire bombs. "What can I do? How big are they? You don't know what to believe." Such are the remarks that fly back and forth. A fire inspector, approaching the desk, overhears the group and offers to explain.

"You can extinguish incendiary fires, if you will act quickly and intelligently," he says, "but you'll have to be your own fire fighters." As he talks, background shots showing fire-department activities flash past, illustrating the reasons why householders must fight blazes themselves.

The camera viewpoint moves to a small home. A young housewife hears a bomb plunge through her roof. She rushes outdoors, starts up a ladder trailing a garden hose. The inspector's voice cuts in: "Remember your hatchet, and use a fine spray." As she proceeds, he continues the background warnings, correcting false moves, until she completes the task of extinguishing the roof and attic fires, and returns to the room below, where she puts out flames licking at curtains and furniture.

Close-ups showing her on the roof were filmed on the small set. Smoke pouring through the roof from oil-soaked rags made these sequences look real. For the ladder-climbing and inside scenes, the shooting was done in the condemned bungalow.

Making the nation safe against all our enemies, within and without, is, of course, the object of defense pictures. By learning to make good defense films, you can help on both counts.

Adjustable Trimming-Board Guide Can Be Set at Any Angle

A PIECE of hard composition board and a slotted strip of either metal or the same material will serve as an adjustable guide and gauge on a trimming board. Prints can be cut to uniform sizes or trimmed at any angle. Fasten the strip by substituting a longer screw for one of those holding the measuring rule. Drill a hole in the square piece near one edge, countersink the head of a bolt from the underside, and attach to the strip with a wing nut.—K. M.

Photo Mounts Readily Made with Cardboard Cutter

MAT-BOARD mounts for photos can be cut with either a right-angle or a beveled edge by means of the new device illustrated. A compass-leg attachment enables it to cut out circles from 1" to 14" in diameter (or up to 36" with the use of an extra 18" leg). Without the leg in place, the tool will cut along a straight line to make square or rectangular openings. Although designed for cardboard mats, it is also a handy tool for linoleum and gasket material.

DEVELOPERS, PART 1

[PHOTOGRAPHY]

	D-72	DK-50	D-11	17	125	Sol. 1	45 Sol. 2	Sol. 3
Water (125° F.)	16 oz.	64 oz.	16 oz.	24 oz.	24 oz			
Elon or metol	47 gr	145 gr	15 gr	22 gr.	45 gr.	145 gr		
Sodium bisulphite	1¾ oz.	4 oz.	2 oz	2 oz	1½ oz		3½ oz	
Sodium sulphite				80 gr		2 oz		
Pyro	175 gr.	145 gr	130 gr	45 gr	1 oz. 60 gr			2¾ oz.
Hydroquinone					2¼ oz			
Sodium carbonate	2½ oz.		365 gr.					
Kodalk		1 oz. 145 gr.		45 gr.				
Borax	27 gr	29 gr	73 gr	7½ gr	30 gr	16 gr		
Potassium bromide	32 oz	1 gal	32 oz	32 oz	32 oz	32 oz	32 oz	32 oz.
Cold water to make								

POPULAR SCIENCE MONTHLY SHOP DATA

DEVELOPERS, PART 2

[PHOTOGRAPHY]

D-72 is a universal developer for film and paper. For film, use one part stock solution and nine parts water, develop five minutes at 65 deg. F. For contact paper, use one part stock, two parts water, develop [illegible] at 65 deg. F. For enlarging paper use one part stock, four parts water, develop 1½ minutes at 65 deg. F.

DK-50 is a normal contrast film developer. For tank development, use one part stock solution and nine parts water; develop [illegible] minutes at 65 deg. F. For tray development use full strength; develop five minutes at 65 deg. F.

D-11 is a strong contrast process developer. Use full strength and develop five minutes at 65 deg. F. When greater contrast is desired, dilute developer with equal amount of water.

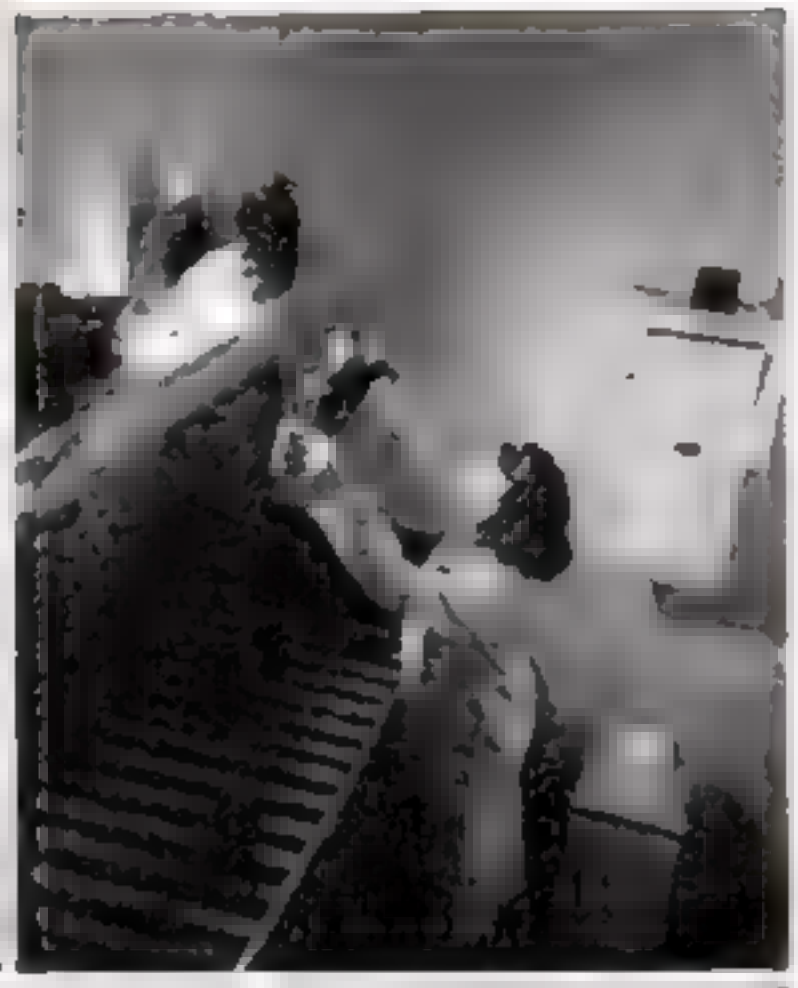
Formula 17 is a fine grain tank developer. Use full strength and develop from 10 to 15 minutes at 65 deg. F. To obtain a greater variation in developing time, substitute 30 grains sodium metaborate for the 45 grains borax.

Formula 125 is a developer for enlarging paper. Dilute one part stock solution with two parts water and develop [illegible] at 70 deg. F.

Formula 45 is a three solution developer for F. For tank development use one part each of solutions 1, 2, and 3, and add eleven parts water; develop 9 to 12 minutes at 65 deg. F. For tray development use [illegible] parts water; develop 6 to 8 minutes at 65 deg. F.

The development times given are for intermittent agitation, and will be cut in half for constant agitation.

POPULAR SCIENCE MONTHLY SHOP DATA



Two enlargers, one for miniature-camera film, are provided by the apartment management

Stainless metal sinks for mixing and washing are large enough for several picture fans to use at the same time

Expert instruction is also available for all who wish it. Here a group of tenants learns to make paper negatives

Apartment-House Photographers
USE COMMUNITY DARKROOMS

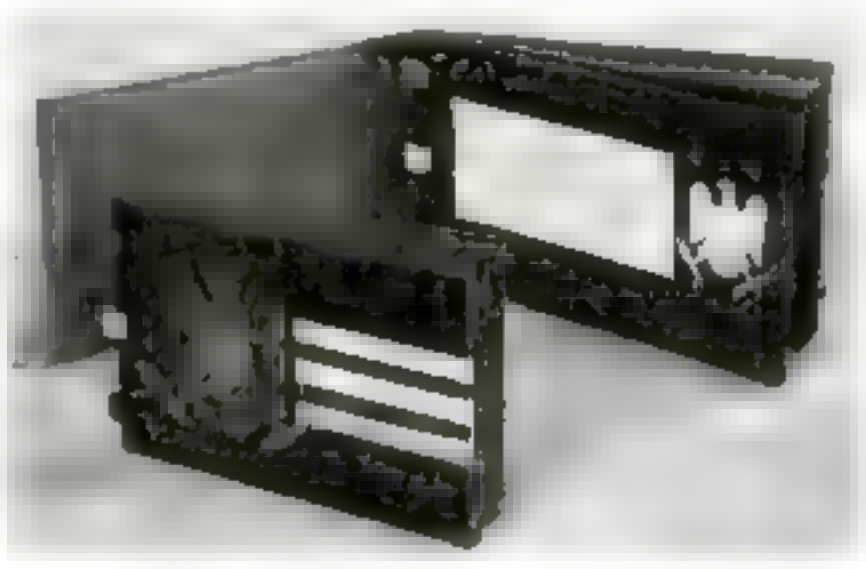
AMATEUR photographers living in small apartments often find it difficult to do their own developing and printing because of the inconvenience it causes other members of the family if either the kitchen or the bathroom is pressed into service as an improvised darkroom. Apartment tenants in large buildings are sometimes able to solve their problem by prevailing upon the management to install community darkrooms.

The darkrooms illustrated are representative of those in sixteen large apartment buildings on Park Avenue, New York. They are equipped with enlargers, printing boxes, stainless metal sinks, and ventilating systems. Tenants may use them by appointment free of charge, and are required to supply only their own film, paper and chemicals. The real-estate firm which manages this group of apartments also made a special arrangement with a school of photography to provide instruction for those who desire it.

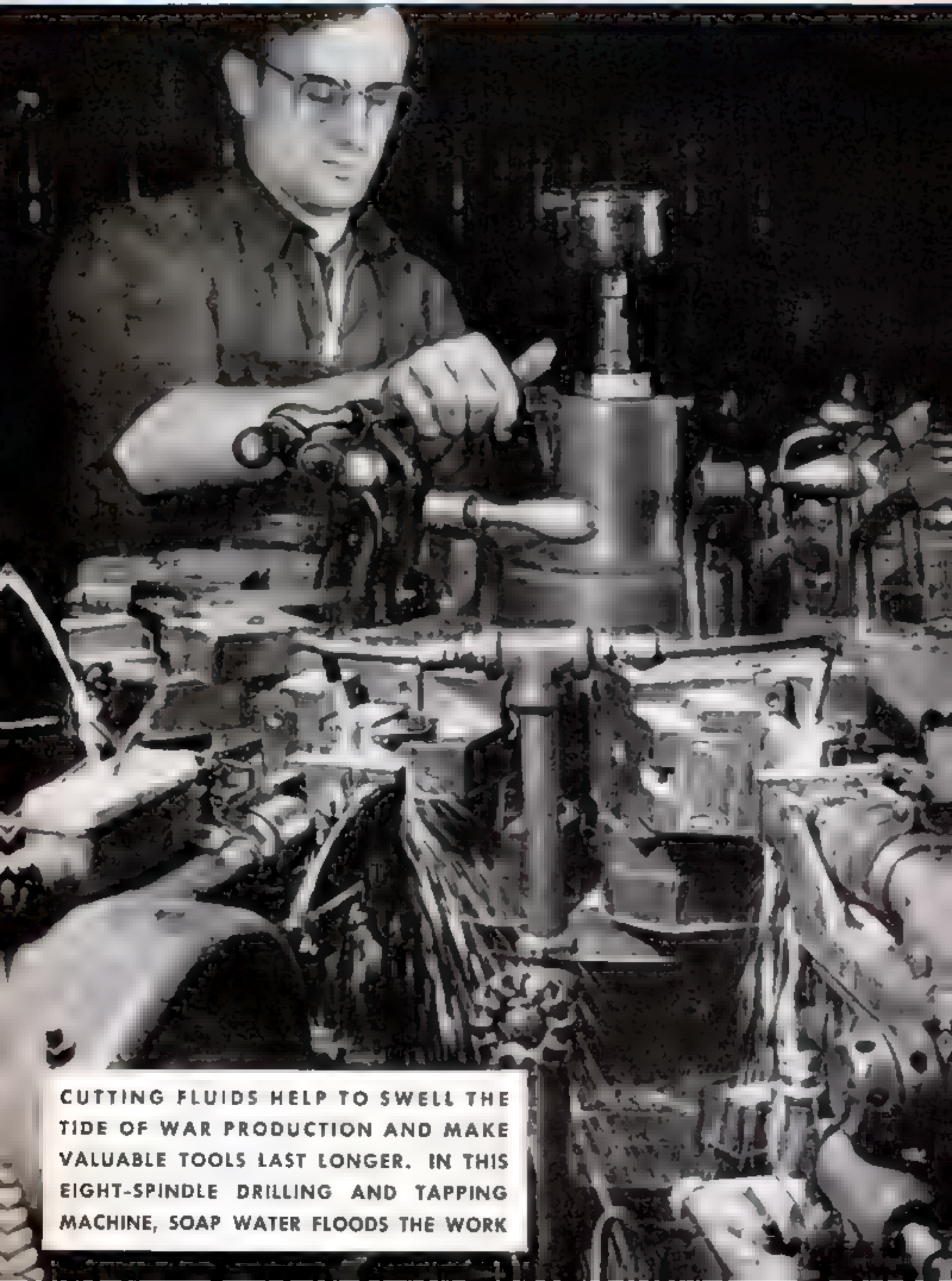
FOR CAMERA USERS

ELECTRIC DARKROOM TIMERS—one that signals with a buzzer at a predetermined interval for developing film or paper and another that automatically shuts off the exposure lamp at its dial setting—are now available for the amateur photographer who does his own processing. The luminous safelight dial of the former is marked in half-minute intervals up to 30 minutes; a dial on the latter for printing and enlarging control of lamps of 1,000 watts or less is marked in seconds up to 100. Push-button control conveniently located on the top of each case starts off the timing hand. When the preset interval has been reached and the signal or light switch set off, the hand returns automatically to the zero point. The same interval may be repeated without resetting. A third timer (not illustrated), which is marked in 15-second intervals up to 10 minutes, is designed for use in processing X-ray film and operates on the same push-button principle. All operate on 60-cycle 105-120 volt current.

NEW KODACOLOR EXPOSURE GUIDES on handy pocket-size cards can be obtained for calculating instantly the correct exposure for either outdoor or indoor picture making. The outdoor guide, shown below, gives full data for various daylight conditions from bright sun to open shade, and shutter speeds from 1/400 to 1 second. An arrow designating the type of subject—dark, medium, or light—is simply set for the light prevailing, and the selected shutter speed at another point on the cardboard turntable will fall on the recommended stop opening. The indoor guide operates on the same principle, giving instant exposure calculations for both flash shots and for floodlighting setups.



ALBUMS WITH A MILITARY NOTE are among those in a new series. The one shown above measures 4" by 6" and has ten dark blue leaves for a total of 20 large prints. Others include folders and pocket cases for Minicolors and transparencies, and hold one to three prints to a leaf. One model with wire binding and snap-button flap provides permanent mounting. For other pictures, albums range in size to 7¾" by 9¾".



CUTTING FLUIDS HELP TO SWELL THE TIDE OF WAR PRODUCTION AND MAKE VALUABLE TOOLS LAST LONGER. IN THIS EIGHT-SPINDLE DRILLING AND TAPPING MACHINE, SOAP WATER FLOODS THE WORK

Machining high-speed steel on a turret lathe in the cellar shop of W. D. Read. A sulphurized cutting oil floods work and tool from a pipe with swivel joints and is recirculated by a pump

Cutting Compounds and Lubricants

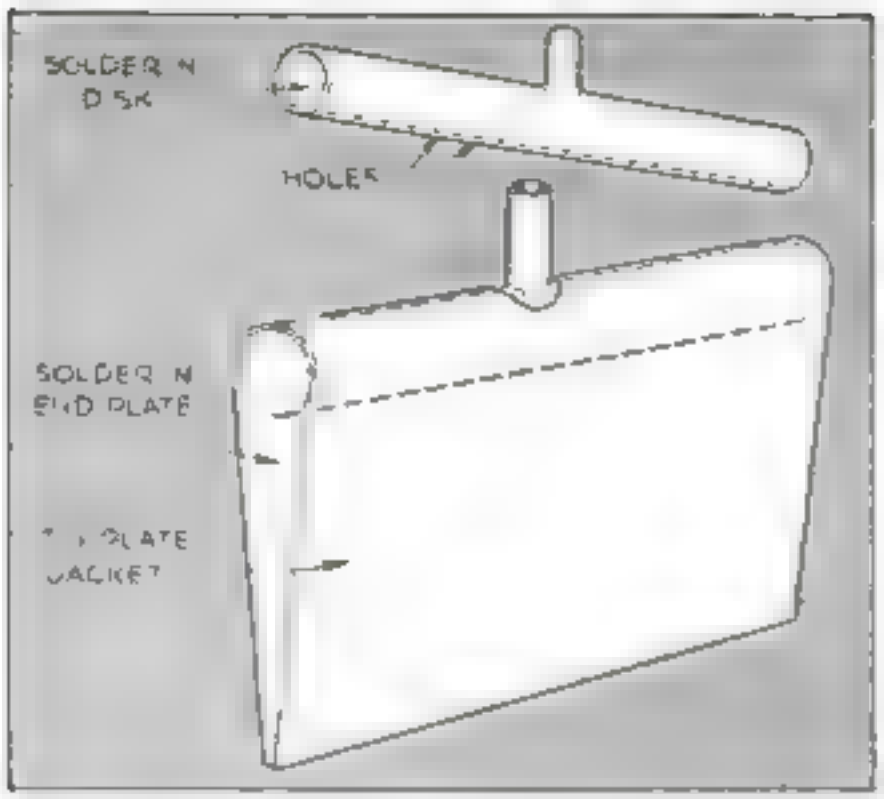
SPEED SMALL-SHOP WAR WORK

By WALTER E. BURTON

MACHINE-SHOP operators turning to war production have found themselves faced with new and stubborn problems in working the incredibly tough, tool-resistant modern alloys specified for Army and Navy equipment. Those problems are solved by the use of fluids fed to the point of contact between tool and work. Not only do these prolong the life of cutting edges, but they make possible better work in shorter time. Often, as in the case of J. E. Flaker, operator of a shop in a small Ohio town, the proper coolant or cutting oil makes the difference between success and failure on a job

Accustomed to machining steel, Flaker got an order for cutting double Acme threads on ⅝" and ⅞" Monel-metal stems for ships' valves. As it was too small to warrant making special dies, he decided to chase the threads on a lathe. Then his troubles began

He ruined the first half-dozen stems because the tool chewed the metal. He tried all the cutting compounds in his shop without success, and then started mixing them. At last he found a way to machine the stems at the rate of one an hour. What solved the problem was a cutting fluid consisting of 2 parts lard-oil blend, 1



This discharge nozzle can be made in any length

part kerosene, and 1 part sulphurized threading oil, applied generously with a brush. The lard-oil blend was 20 percent pure lard oil and 80 percent mineral oil of 200 at 100 Saybolt viscosity. The threading tool was finish-ground on a 240-grit wheel, and then honed on an Arkansas stone.

"With the tool sharpened that way," Flaker said afterward, "and with plenty of the cutting compound, I whisked out mirror-like threads I could see myself in."

Another suitable compound for the job might be a sulphurized mineral cutting oil containing fat, thinned with 2 percent (by volume) of kerosene.

The same shop had trouble in machining soft boiler-plate steel smoothly, till Flaker worked out a cutting compound consisting of 1 part cottonseed oil and 9 parts lard oil. This mixture, he says, is suitable for any tool that cuts with a sweeping action.

The owner of an Akron, Ohio, basement shop from which have poured thousands of rotary files, countersinks, and other small tools used in aircraft production, for some time fought a losing battle with 6-6-2 high-speed steel. Rods ranging up to ⅝" in diameter had to be turned to form, threaded, and cut off in a small turret lathe. A hardened steel bushing used to guide the rods was one point of difficulty. Despite the use of a cooling emulsion of soluble oil in water, wherever the rods were a bit oversize, they would gall in the bushing. Furthermore, the threading tap would not stand up.

A solution of yellow soap in water reduced the bushing trouble, but a ¼"-28 tap would still survive no more than a dozen cuts. The operator turned back to the emulsion, adding some lubricating oil, but results were still disappointing. Then he introduced some colloidal graphite, and an immediate improvement in the turning operations resulted. Tapping, however, still gave trouble.

This determined machinist next tried sulphurized cutting oils. The tapping and bushing-gall troubles vanished, but the cutting edges of the tools began to glaze. At this point he knew how to turn, thread, and cut off the steel perfectly, but he couldn't do them all with the same cutting compound. Finally he told his troubles to the manufacturers of the sulphurized oil that had come nearest to turning the trick. A chemist visited his shop, studied the operation, and worked out a blend that included all the good points of the various compounds

CUTTING COMPOUNDS—GENERAL [SHOP PRACTICE]

Material	Drilling, Turning Milling, Reaming	General Grinding	Grinding Threads	Threading	Knurling
Aluminum and its alloys	Emulsion 1 15 Mineral cutting oil containing fat plus equal volume kerosene Turpentine Kerosene	Kerosene alone or with mineral oil	Cutting oil plus kerosene as for drilling	Same as for drilling	Same as for drilling
Brass Bronze	Dry Emulsion, 1 30	Same as for drilling	Same as for drilling	Same as for drilling	Nonstaining fatty sulphurized oil
Carbide-tipped tools		Emulsion 1 30 Special grinding-oil emulsion			
Cast iron	Dry Weak emulsion	Emulsion 1 30		Same as for drilling	Sulphurized oil containing fat
Copper	Lard oil and kerosene equal parts Special cutting oils Lubricants suggested for aluminum			Same as for drilling	Same as for drilling
Magnesium	Equal parts kerosene and pure lard oil. Never use any compound containing water				
Steel, free-cutting	Emulsion 1 30 Soda water Cutting oil* (for good finish)	Emulsion, 1 30 Special grinding emulsion	Sulphurized oil containing fat	Sulphurized cutting oil Special threading oil	Sulphurized oil containing fat
Steel, tough alloy	Sulphurized cutting oil, with or without fat	Emulsion, 1 30 Special grinding emulsion	Sulphurized oil containing fat	Sulphurized cutting oil Special threading oil	Sulphurized oil containing fat

*NOTE: Lard oil may be used for milling and sulphurized cutting oil for reaming carbon steel as well as the other compounds listed

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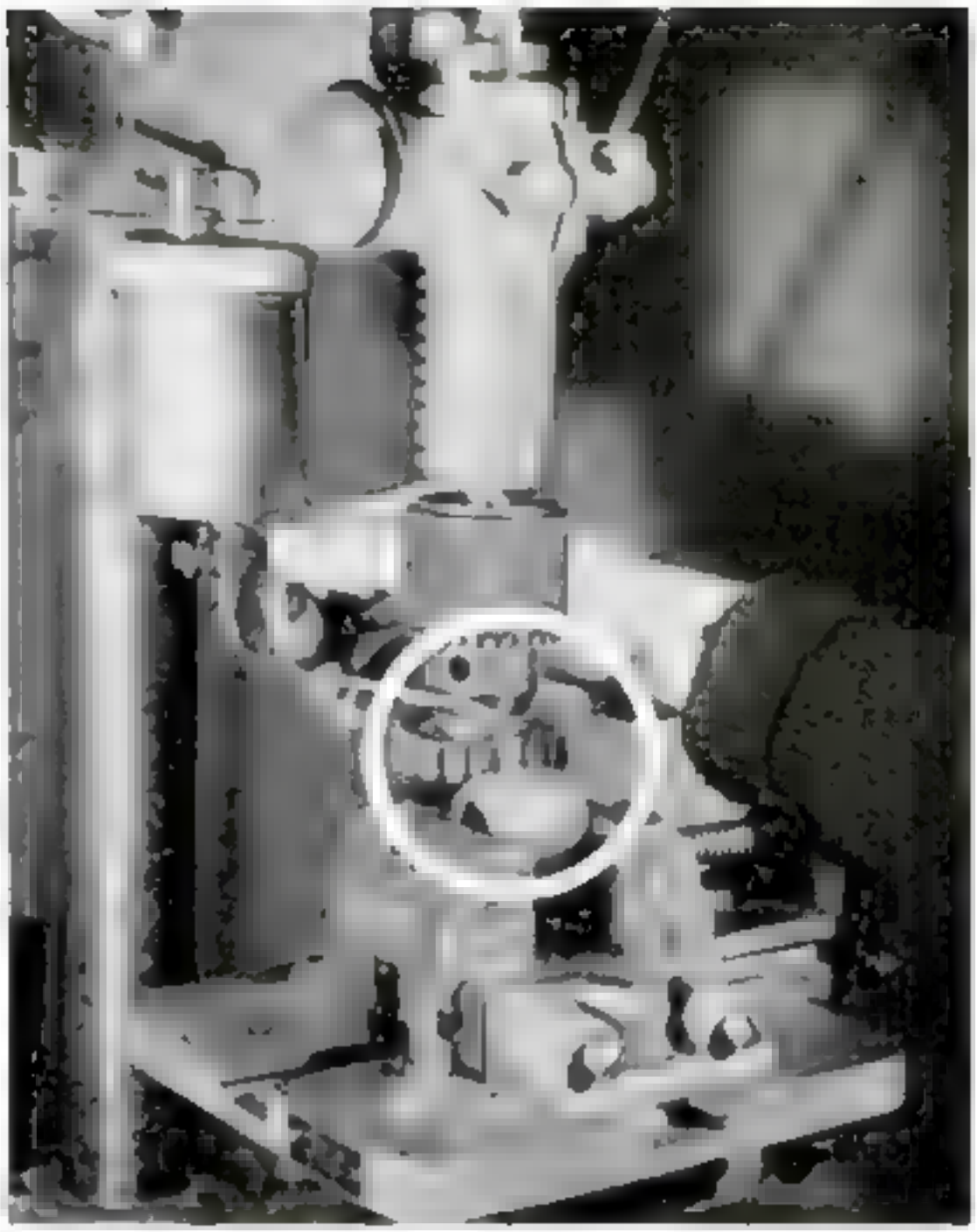
tried. This miracle-working oil makes it possible to machine high-speed steel at an unbelievable rate. It is fairly clear, and contains chlorine and sulphur. The manufacturers have made it a standard item.

A tour of small shops engaged in general tool making and machining, and in bits-and-pieces production, revealed some curious attitudes toward lubricants and cutting fluids. In one a man was drilling ¼" holes 2" deep in the ends of steel bars. He first drilled 1" of the hole dry, then lifted the bit, squirted a little oil into the hole, and drilled the remaining 1". Why he did not use oil for the first inch is a mystery.

At several shops the view on cutting compounds was: "We don't have enough work to bother with such stuff Sometimes we use oil in drilling, but not for much else."

Judging by such remarks, it would seem safe to say that scores of shops are wearing out tools, wasting time, and turning out inferior work because they don't use *any* cutting oils or coolants. Cutting compounds show to best advantage in high-speed production machining, but even



Set up for light milling, this drill press gets its lubrication through a drop oiling arrangement consisting of a small coffee can with a petcock and copper tubing soldered to the bottom. Such a system is suitable for shallow cuts at relatively low speed. It may be used also on a lathe or for oiling bearings

BEARING LUBRICANTS [SHOP PRACTICE]

Bearing or Friction Surface	*Speed*	*Oil Viscosity*
Grinder bearings	Very high	100 Saybolt at 100 10W motor oil
Shop-machine and bronze motor bearings	Medium and high	150 Saybolt at 100
Gear boxes and sliding bearings	Medium and slow	200 Saybolt at 100 20W motor oil
Small and medium ball bearings	— — —	150 to 200 Saybolt at 100
Large ball bearings, roller bearings		200 to 300 Saybolt at 100
Small grease-packed ball bearings*		Very soft, oily cup grease Special ball-bearing grease
Large grease-packed ball bearings*		Soft, oily cup grease Special ball-bearing grease
Unenclosed gears; racks, worms, screws	— —	Mineral gear lubricant (about 1 000 Saybolt at 210)

NOTE 100 Saybolt at 100 means 100 seconds Saybolt at 100 degrees Fahrenheit," in Saybolt Universal Viscosity System

*For grease-packed bearings, use grease recommended by maker of bearing or machine whenever possible

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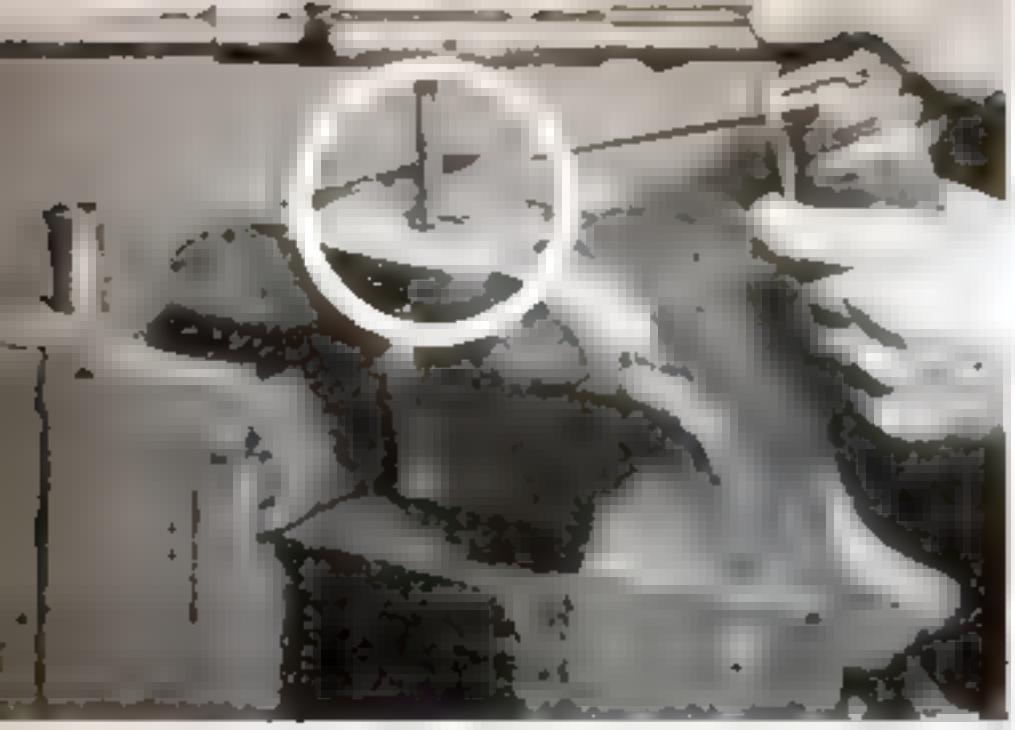

Hand threading is made easier and tools will last longer if a little sulphurized cutting oil or special thread-cutting oil is applied with a can or brush. Lubricants help in the simplest operations

Cutting compounds squirted on from a can often are adequate when threading in a lathe, for this is a relatively slow-speed, light-cut operation The threads will be smoother than those cut dry

Colloidal graphite mixed with oil is brushed on the dovetail slide of a lathe carriage to reduce chatter. Graphite is commonly used in new and refitted bearings during the running-in period

the simplest cutting operation on most metals can be improved by either a squirt or a flood of oil or by a stream of coolant. You can prove this to yourself easily. Drill two holes with a No. 7 bit through a piece of steel ¼" thick. With a ¼"-20 tap, thread one of them dry. Now, if you didn't break the tap in the first test, put a few drops of sulphurized cutting oil on it, and thread the second hole. The difference will astonish you. Special threading oils are now made by a number of manufacturers, but sulphurized cutting oils are excellent for most hand and machine tapping.

Attempts to drill Monel metal dry usually result either in quickly rounding the point of the drill or in burning it. Kerosene is often used as a drilling compound, but a sulphurized cutting oil, either straight or thinned with a little kerosene, makes the chips curl out more readily.

Sometimes the problem is one of cost rather than of machining A small Ohio shop got a job turning wide, deep grooves in 4" steel stock that had been compacted by hammering into rough cylinders. The lathe tool, bathed by a stream of commercial nonsoluble cutting oil, was taking a fairly heavy cut at low speed, and turning out long, ribbonlike chips with ease

"But it costs too much," the shop owner complained. "I lose four or five gallons of oil a day because it clings to the chips."

A fairly rich emulsion of 1 part soluble oil to 15 parts water, directed in a generous stream so that much of it struck the back of the chip, cooling and shrinking it to make it curl freely away from the cutting edge, solved this man's cost problem

Confusion often results because for one job there may be several cutting compounds that work perfectly, while for another there may be only one—and that hard to find. Frequently a lubricating engineer can point out the right one. However, few shops can keep such an expert on hand, and the machinist may have to rely on experience or trial and error when the work sheet is marked "rush." With experience, he can often select wisely, and initial failure should not discourage him.

A coolant is essentially plain water with a soluble oil or something else added to prevent corrosion. It washes chips away from the cutting edge, keeps the latter cool, and prevents distortion of the work from overheating. A nonsoluble cutting oil has some cooling action, but its chief functions are to keep chips from sticking to the tool

edge, reduce friction, improve the finish, and make heavier cuts possible. Soluble oil added to water makes an emulsion, generally valuable when the temperatures developed are too high for the use of an undiluted oil.

One shop has been using soda water for 12 years as a coolant for milling and grinding high-speed steel because some soluble-oil emulsion once tried produced a gummy deposit. Soda solution is an old-time coolant, the soda acting to prevent rusting. It is not, however, easy on the hands, and it provides no lubrication to prolong tool life. Like soda water, lard oil, another cutting compound used for years, is also giving way to cutting oils and emulsions. The soda user might speed production and double or triple the life of milling cutters by switching to an oil or emulsion—one that doesn't gum. One of the new soluble grinding oils probably would improve the finish of his work and make wheel dressings necessary less often.

Another shop, starting work on stainless-steel parts, ran into trouble with thread milling; the cutter simply chewed the stock. All the cutting compounds in the shop were tried without success. A visiting steel salesman suggested that a certain brand of thread-cutting oil be tried. The shop owner, in desperation, ordered a 5-gal. drum. That oil turned out to be just what was required.

This incident illustrates a fact worth remembering, namely that a particular problem may be solved only by a particular brand of oil. Manufacturers' formulas differ considerably even for oils that apparently are identical.

For the machinist who wants to see what he is doing, or when maintenance of close tolerances requires careful watch of the action of a tool, a transparent cutting oil has been developed. Print can be read through a 1" thick stream of it.

Bearing oils and greases are as vital to successful and economical shop operation and the preservation of shop equipment as are cutting compounds and coolants. Most requirements for bearing lubrication can be met by three viscosities of machine oil and two grades of cup or ball-bearing grease. Machine oil is cheaper than comparable grades of automobile motor oil, but many shop owners think motor oil is better. In one three-man shop, the standard bearing lubricant for years has been oil drained from crankcases. It is placed in a container and left undisturbed for 12 months or more, then the clear top portion is decanted, leaving impurities behind. Sometimes a small amount of penetrating oil is added to increase penetration into small-clearance bearings.

Colloidal graphite has earned a place in many shops. In one, the addition of graphite to oil in a multiple-spindle gear box lowered the temperature 15 degrees in an hour, reduced current input from 7 to 6 amperes in a few minutes, and stopped frothing of the oil instantly. A mixture of graphite and a little lubricating oil, brushed on ways, gibs, and other bearing surfaces, reduces chatter caused by momentary breakdown of oil films. Graphite is commonly used in new and refitted bearings during the running-in period, on gears and in bearing grease, and in new machines to reduce static or starting friction.

CUTTING COMPOUNDS—STEEL [SHOP PRACTICE]

	High Speed	*Low Speed*
Heavy cut	Emulsion, 1 20 to 1:30*	Cutting oil containing sulphurized fats Fairly rich emulsion such as 1:15
Light cut	Emulsion, 1 30 When good finish is desired, as in milling threads rich emulsion, 1 5 to 1.10 Sulphurized oil	Machine dry Lean emulsion Any cutting oil

Emulsions are made by mixing soluble oil and water preferably distilled water or condensate when very best results are desired. The ratio 1 30 [redacted] 1 part oil to 30 parts water.

NOTE: The above are general recommendations only. Special alloy steels may require other compounds or blends

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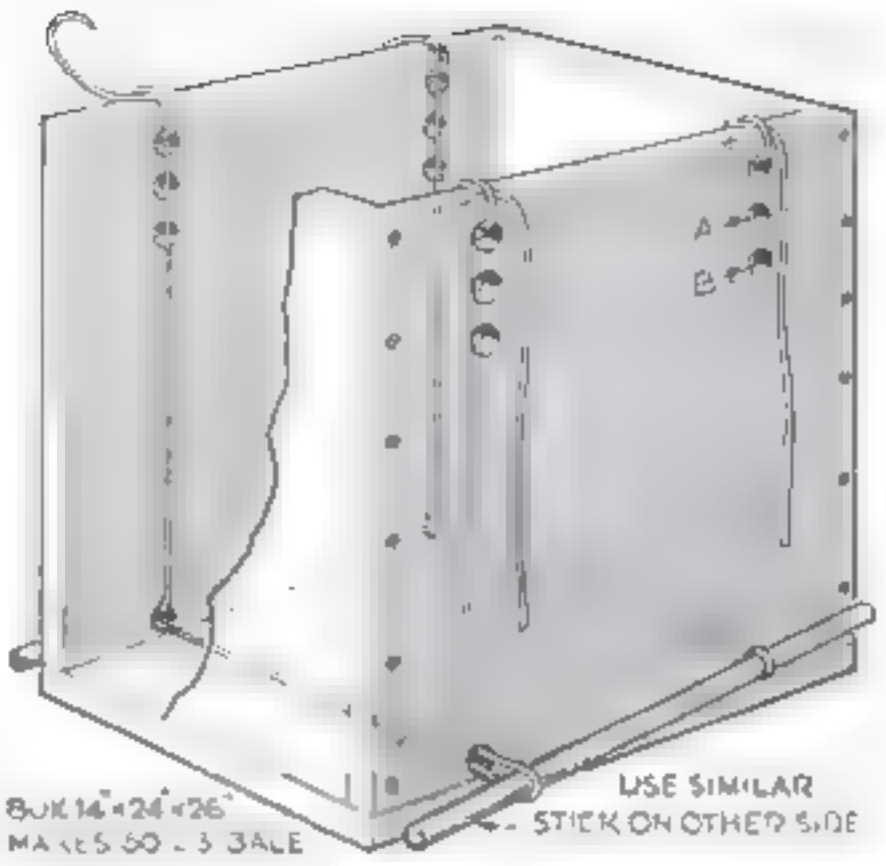
Wastepaper Neatly Bundled in Packing-Box Baler

TO SIMPLIFY the handling of wastepaper collected, the Boy Scouts of Troop 65, Union, N. J., built a simple box baler that makes neat, tight bundles even when collections consist largely of small scraps, circulars, bags, and the like

Any strongly built box will do, but one that is deep in proportion to its width is preferable. Holes are drilled in both sides as shown in the drawing, and the baling cord is drawn through the bottom ones, secured with two pieces of broomstick, and tied through the top ones.

A layer of newspapers or large sheets of cardboard is first deposited, followed by some smaller scrap. On top of this, a tamping board 2" shorter and narrower than the box is laid. The packer stands on this to compress the paper. Repeat until the box is full, then place on top another layer of large pieces, pull the broomsticks out of the loops, and compress the paper enough to push the sticks through the holes *A* or *B*. Pull the cords taut and tie them. The broomsticks can then be pulled out and the bale removed. A third cord can then be tied lengthwise.

Mounted on wheels, the baler serves as a collection wagon.—HERMAN A. BISTRITZ.



Easily Applied Finishes Make New Fixtures from Old

OFTEN it may be found possible to get double or triple service from electrical items such as sockets, switch plates, shade brackets, and similar accessories, which were formerly replaced. One way, if the mechanism is still good, is to recondition old fixtures with modern lacquers or enamels. Crackle or crinkle lacquer is particularly effective. If it is to be baked in an oven, remove all wiring, insulating material, and other parts that might be damaged by heat. Brass socket shells are best refinished by spraying after they have been reassembled to prevent gumming of the joint. The clear lacquer on brass fixtures need not be removed, but clean off dirt and grease before refinishing them—W. E. B.

Dish Cover on Bicycle Seat Keeps It Dry in the Rain

A LARGE oiled-silk cover such as those equipped with elastic bands and used on refrigerator dishes may be stretched over the seat of a bicycle to keep it dry when the wheel is parked in a school yard or some other open place during rainy weather.—B. N.

MODERN *Spool Holder*

Designed by JUAN OLIVER

IN THE busy household, this spool holder fills a real need by keeping a large assortment of sewing threads and needles in one convenient place.

Lay out *A*, *B*, *C*, and *D* by tracing them from point to point on ½" squares just as they are on the smaller squares in the drawing. Be sure to mark the location of the pivot hole and spool pegs on each.

A piece of ½" thick soft fiber board is glued to the thin piece *A* and sawed to shape with it. Sand all the edges smooth. The collars are turned or made by boring through pieces of 1¼" dowel. A ⅝" thick section of the same stock forms the cap, which is doweled and glued fast to the ¾" dowel column. Slot the end of the latter and lock it with a wedge in the base *D*.

The original piece was finished with clear lacquer, but any appropriate finish may be applied.

IDEAS for HOME OWNERS

HERE IS A COLLAPSIBLE WHEELBARROW that takes so little space for storage that the home gardener with limited room for tools can hang it on the garage wall. Front, sides, legs, wheel, and handles fold flat against the bottom, forming a compact 30" square about the size of the average card table. When set up, the barrow is large enough for trundling long-handled garden tools along with the smaller implements, seeds, plants, spraying equipment, and the like, and is sturdy enough for general construction or excavation work as well as the ordinary backyard and garden jobs. A carrying handle is so placed as to permit it to be carried when folded without dragging on the ground.

Folded, this wheelbarrow can be hung out of the way on a garage wall; set up, it is a sturdy carry-all for general use around the garden

PAINTBRUSH PROTECTION is aided with the combination coupling and rack shown at the left. The device can be screwed onto the threads of two ordinary fruit jars, making them an airtight container for brushes and the cleaning or keeping fluid. Slots in the coupling serve as racks for the brushes.

PACKINGS FOR REPAIRING PUMPS and other water systems are now put up in kits, each marked for the specific type for which the parts are designed. The contents include rubber valves, springs, plunger crimps, valve cores, gaskets, and washers.

INSECT SPRAYING WITH THE HOSE may be done with the aid of this attachment which weighs, when filled with concentrated liquid insecticide, just over a pound and mixes with water to make 1½ gallons of spray. The unit is connected to the hose in place of the regular nozzle, and is controlled by a leakproof thumb button which will stand water pressure up to 150 pounds. A deflector on the end of the nozzle revolves to send the spray up or down or to either side to assure covering all types of plants. It can be removed for straight spraying or for reaching high vines and the tops of trees.

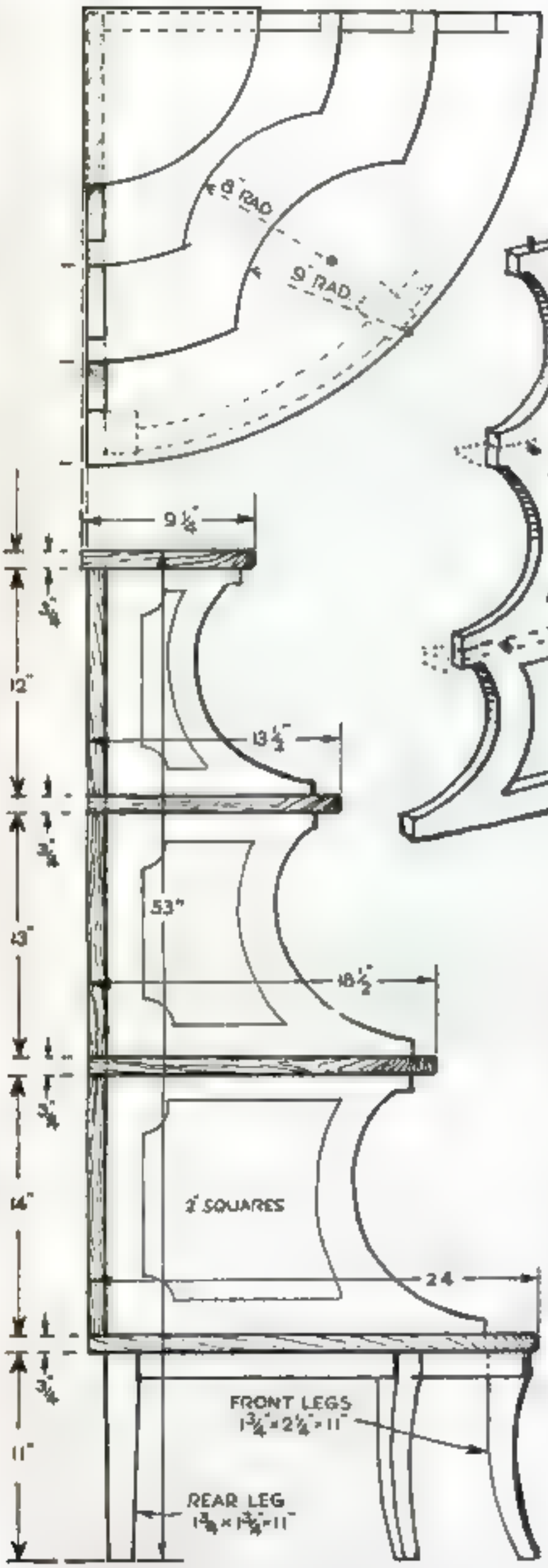
BLACKOUT ACCESSORIES FOR THE HOME

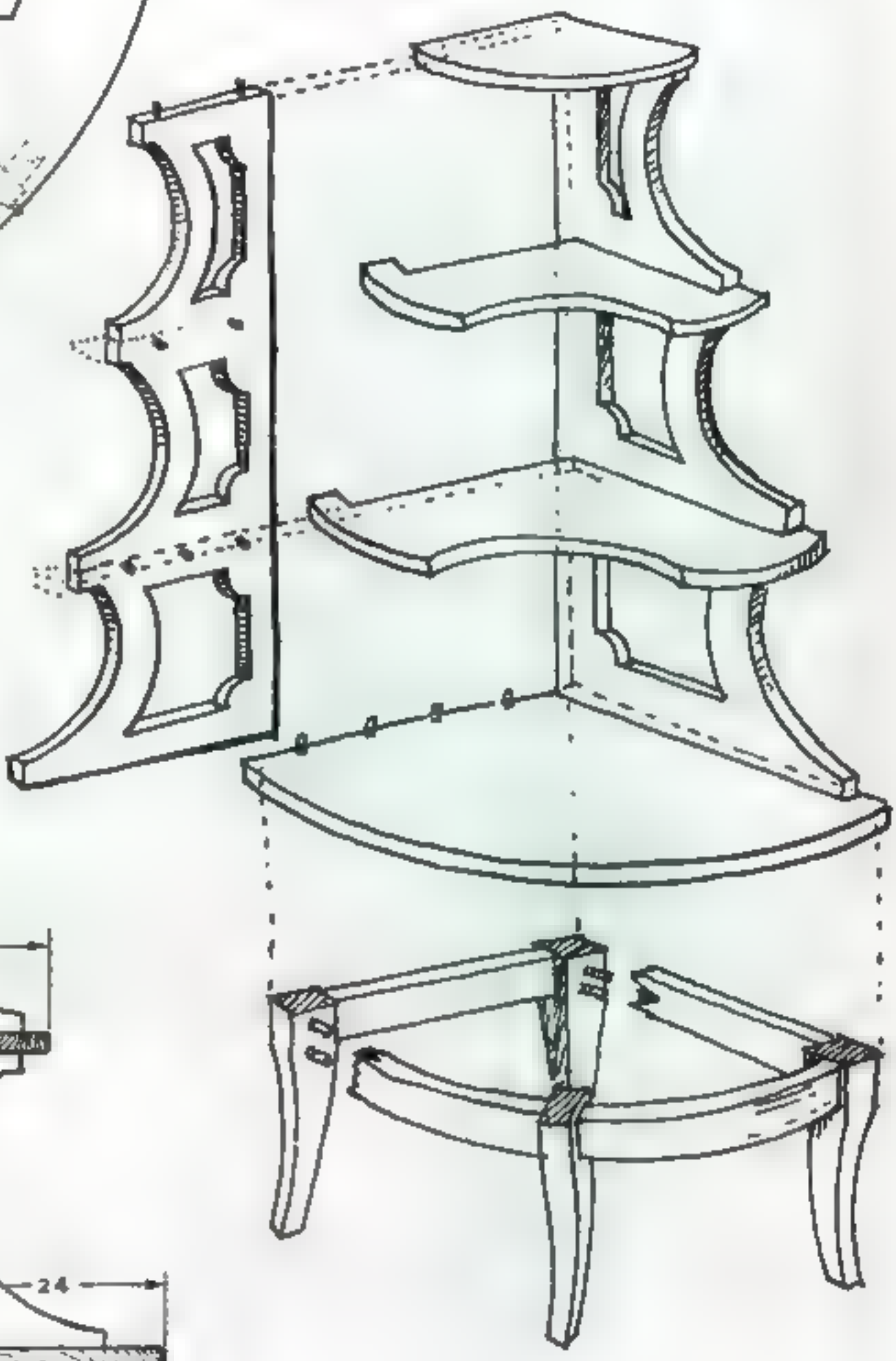
THIS SPLINTERPROOF QUILTED WINDOW PAD barricades a room against flying glass as well as shielding inside light from outside view. Black dye on the window side of the pad is color-tested to resist the effects of rain; the room side is white to lessen dullness and conserve light by reflection. The pad is hung by loops on pegs which come with it and are driven into the wall. When not in use, it may be rolled up like a beach pad and stored where it may be reached quickly. Three sizes are made, the largest 63" by 90".

HEAVILY COATED BULBS that provide a safe light that won't leak out through unprotected windows are now made with a deep orange glow instead of the blue and red formerly turned out by the same manufacturers. They also may be had now as small as 15 watts. A black silicate coating is used to darken the sides.

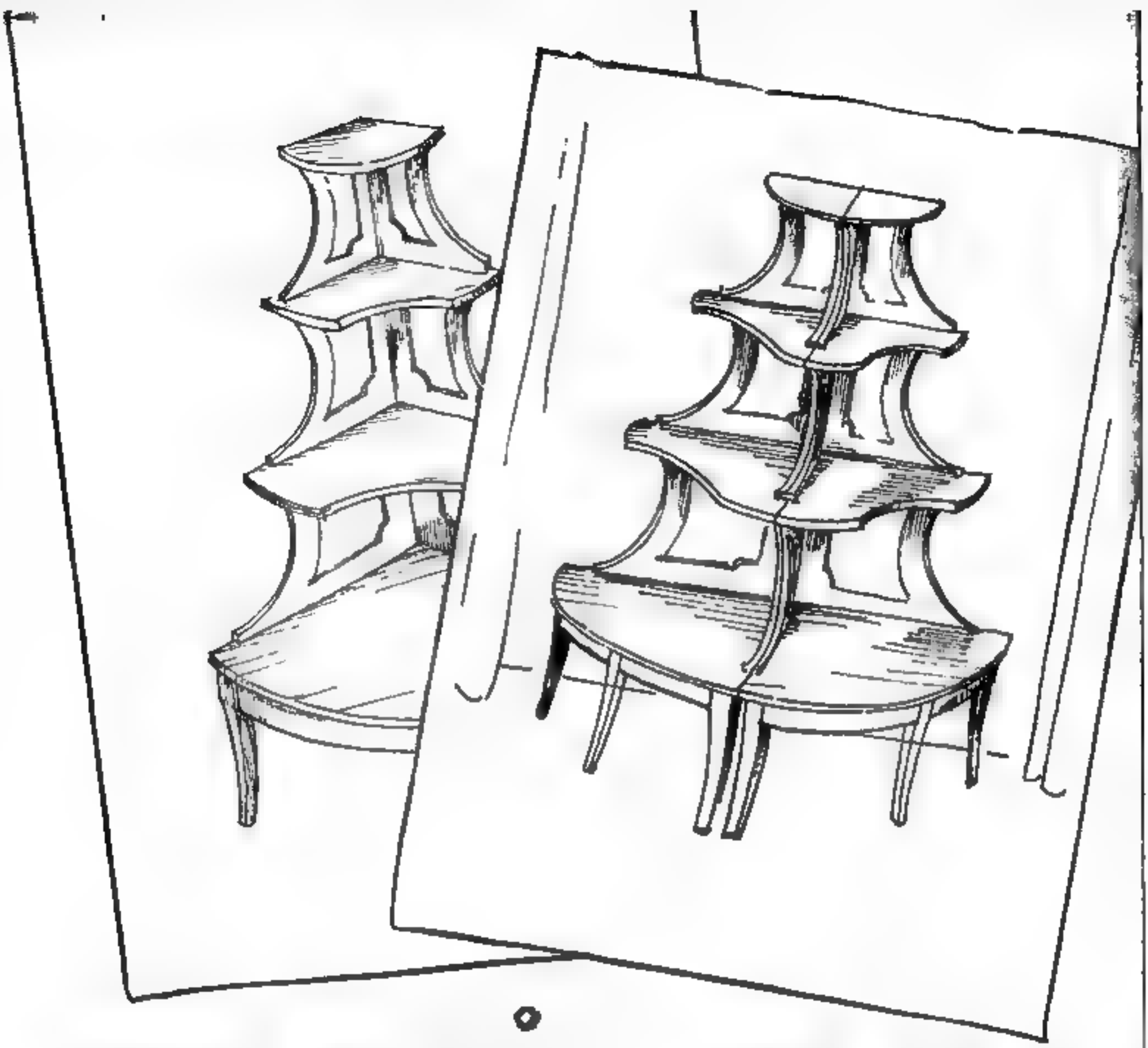
HOSE FOR FIGHTING INCENDIARY BOMBS comes provided with white sections at both ends, as shown below, to assist in locating the coupling and nozzle in the dark. White-sidewall tire paint is used to obtain the result. Otherwise the hose is of the garden-and-lawn type that can be coupled to the ordinary household faucet fitted with threads. Its spray nozzle makes it an adjunct to a shovel and bucket of sand

Each stand requires four quarter-round shelves of ¾" stock with radii 9¼", 13½", 18½", and 24". The arc of the two intermediate shelves is interrupted with a reversed curve, and these two shelves are cut to let the sides into them





Two sides will be needed, one 20" wide and the other 20¾". Both are ¾" thick and 40½" high. The legs are of 1¾" stock, 11" long, the rear one square and tapered, and the other three 2¼" wide at the top and curved as shown. Rear stretchers are 1⅜" by 1⅜" by 19", and the band-sawed front ones 1⅜" by 2½" by 14½"



CORNER WHATNOT OR PLANT STAND

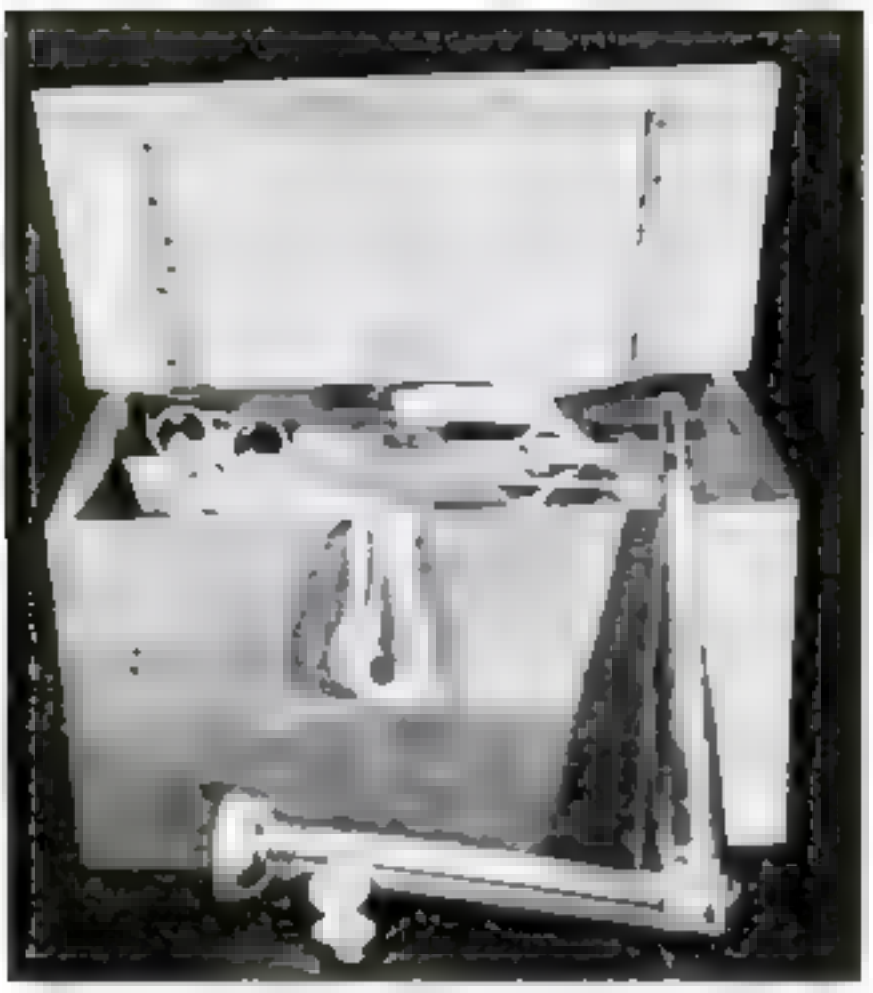
By JOSEPH ARONSON

CORNER furniture is much in demand to relieve dull spots in decorative schemes. This stand can easily be made by any home craftsman having moderate skill, and from any material he chooses. A pair of such stands may be used together in a wide window to display plants, or facing each other from the two ends of a double window. Used alone as a whatnot for small sculptures and curios, one stand will fill a corner in the living room or the hall to advantage

A simple but pleasing effect is possible by the use of pine or fir plywood, finished in antique or pickled tones. If cabinetmaker's plywood is available, handsome pieces can be made of mahogany panels finished in an antique tone.

Band-saw the side panels to shape first. The cut-out openings in these are not absolutely necessary, but they tend to lighten the design. Both intermediate shelves are cut so that the sides may be let into them, but the top and bottom shelves overlap the edges of the side panels. All are doweled and glued together.

The base is made as a separate framework, the legs and aprons being band-sawed out of 2" stock. These also are doweled together. The base is screwed or glued fast to the lower shelf.

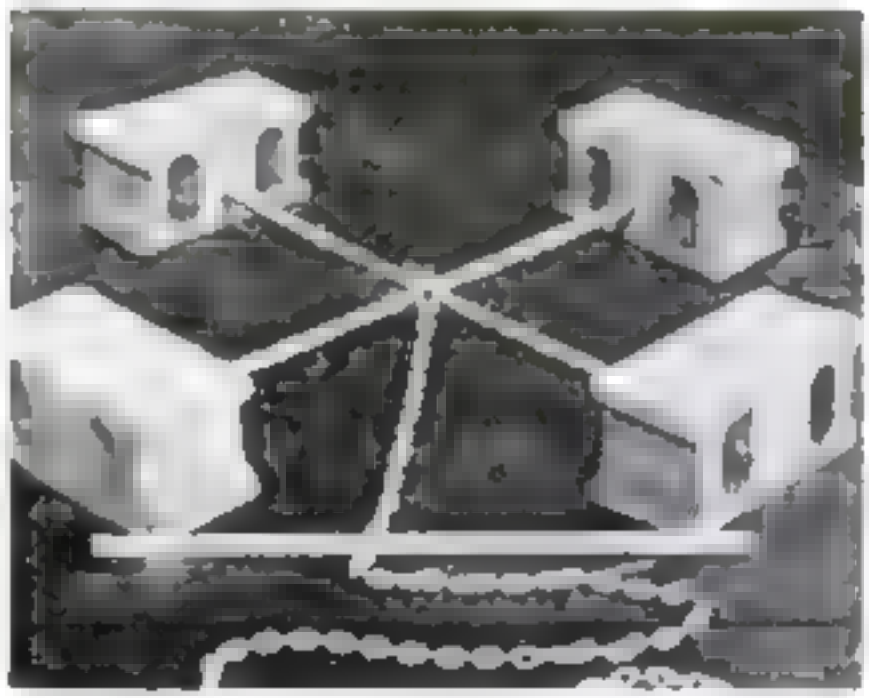


Pipe-and-Concrete Cross Used for Permanent Boat Mooring

THIS heavy boat mooring, proof against being pulled from its bed, is built on a raft, floated into position, and tipped off. Screw four 24" lengths of pipe into a threaded ¾" galvanized cross, put tees on the ends, and cement a common concrete building block over each tee. A lap link holds the anchor chain.—H. B. HENRICKSON.

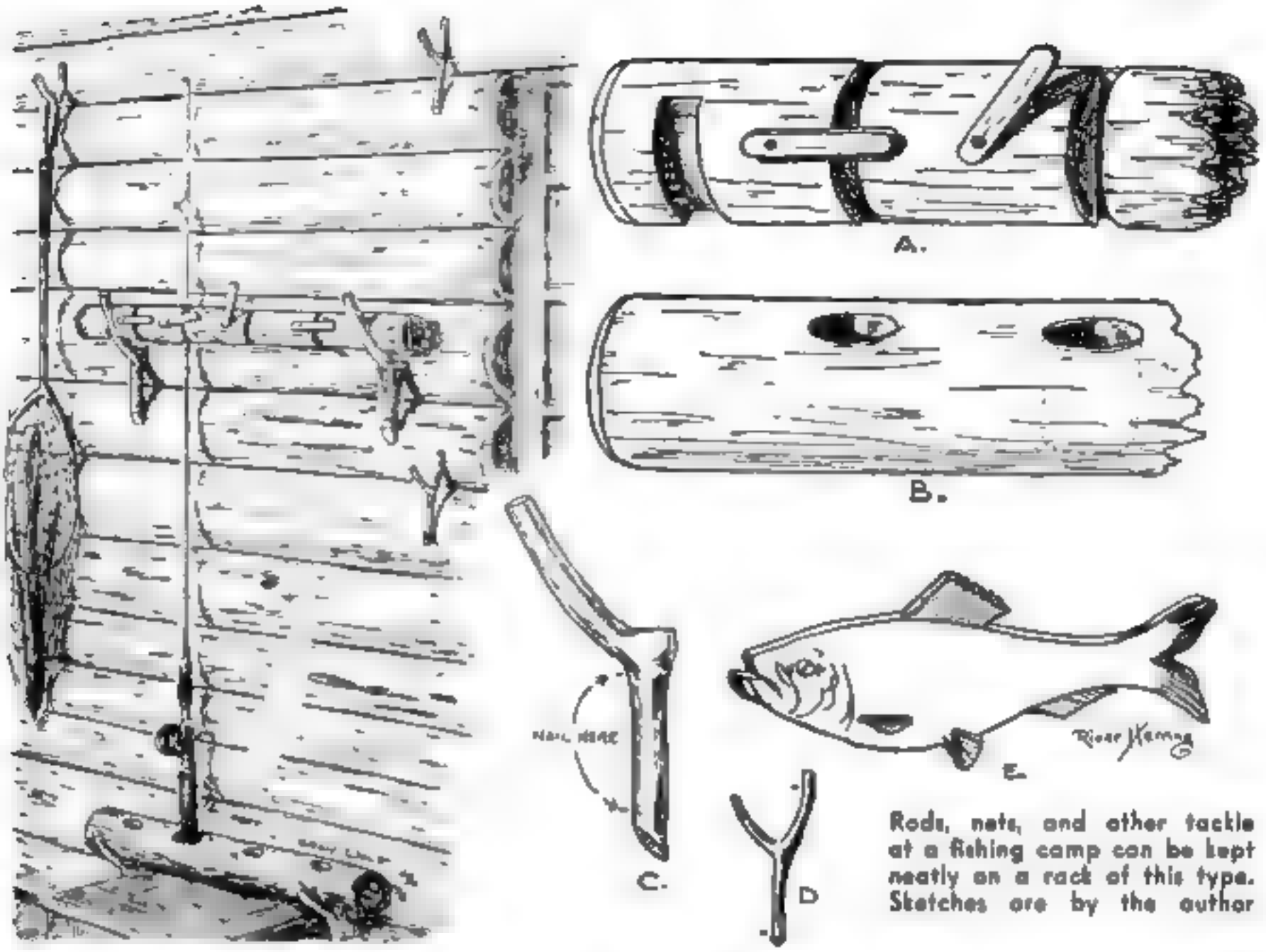
Chest Provides for Storing Equipment Aboard Boat

A CHEST has advantages over a built-in locker for storage aboard a small boat. It can be removed to lighten the weight of the hull when the boat is to be beached or carried into a boathouse and can be used as a low table or bench as well as a locker. The size of the chest shown is 13" by 22", and the height is 12". Bottom and sides are cedar; ends, top, and small-articles tray, pine. Join with waterproof resin glue reinforced with screws. Be sure to use brass screws and hinges, copper nails, and marine spar varnish throughout. If the floor of your boat slopes, slant the bottom of the chest and keep the sides vertical.—J. C. MONTGOMERY.



Fireplace Fitted with Socket for Removable Cooking Arm

SOMETIMES, especially in cabins and country homes, it is desired to hang a teakettle or a cooking pot in the fireplace. This can be done easily enough if a socket is permanently built into the side brickwork or masonry of the fireplace. A good socket can be made from a long 1" pipe nipple with a 1" coupling screwed on the end. The nipple serves as an anchor, and the coupling, short as it is, forms a sufficiently secure socket. Cement these parts in at a slight upward angle so that the arm, which fits the socket rather loosely, will project horizontally and not sag. The arm is a 20" length of ¾" pipe (unthreaded). It is merely pushed into the socket when needed. Any other size pieces of scrap that are available and will fit together as described may be used.—J. M.



Rods, nets, and other tackle at a fishing camp can be kept neatly on a rack of this type. Sketches are by the author

Rustic Wall Rack Built of Small Logs to Hold Fishing Rods

A RUSTIC fishing-rod rack for a summer cabin or camp can be made from materials in the woods. The top bar *A* is 3" in diameter and as long as needed. Notch it near each end for the brackets *C*, and gouge out a notch for each rod. To hold the rods, strips of wood serve as turn buttons. They can be carved in the shape of fish, as at *E*, with the screws for eyes. The lower bar *B*, 4" in diameter and as long as the top bar, has holes 2" deep to correspond with the other's notches. Leave room under it for a tackle box. Nail up forked branches, trimmed as at *D*, for other equipment.—GRAY WOLF.

JAVELLE WATER

[FORMULAS]

Javelle water, a solution of sodium hypochlorite in water, is a bleaching agent, cleanser, and disinfectant. It is easily made as follows:

Add soft water slowly to ¾ lb. chloride of lime in an enameled pan, crushing the lumps to make a smooth paste. Put 3 lb. washing soda in a 2-gal. stoneware crock and add 1 gal. warm water. When the soda is dissolved, add the lime paste and enough water to fill the crock. Leave covered for several hours, until the lime settles; then dip or syphon off the clear liquid. This is a concentrated solution and should be diluted with four times its volume of water before use. The above quantities therefore make nearly 10 gal. of solution.

Only soft water should be used in the above formula. Do not allow Javelle water to drip on clothes or other fabrics. Metal fixtures with which it has come in contact should be washed immediately with clear water and dried.

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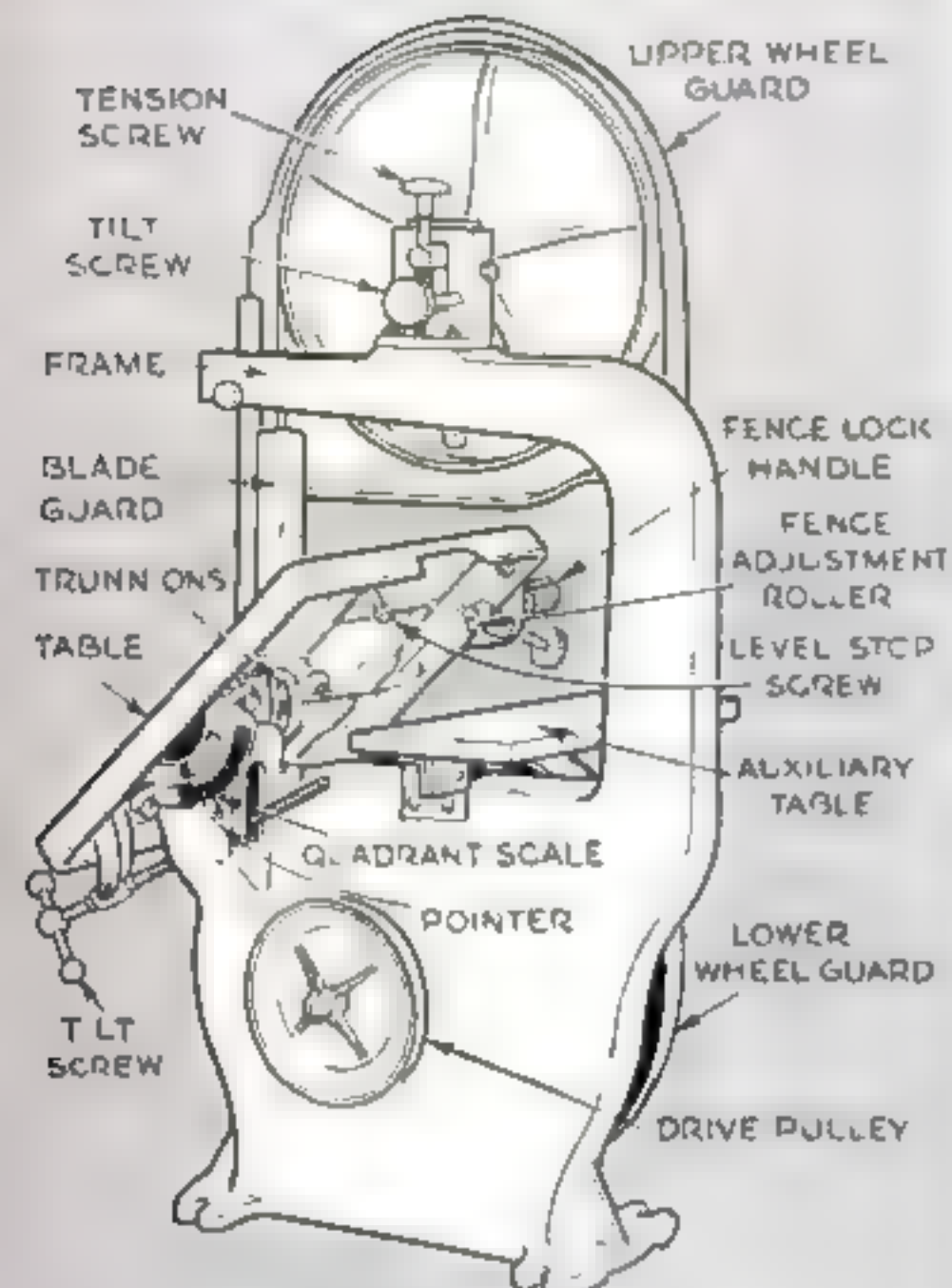
Setting Up and Using a

By EDWIN M. LOVE



TYPICAL BAND SAW
(BACK VIEW)

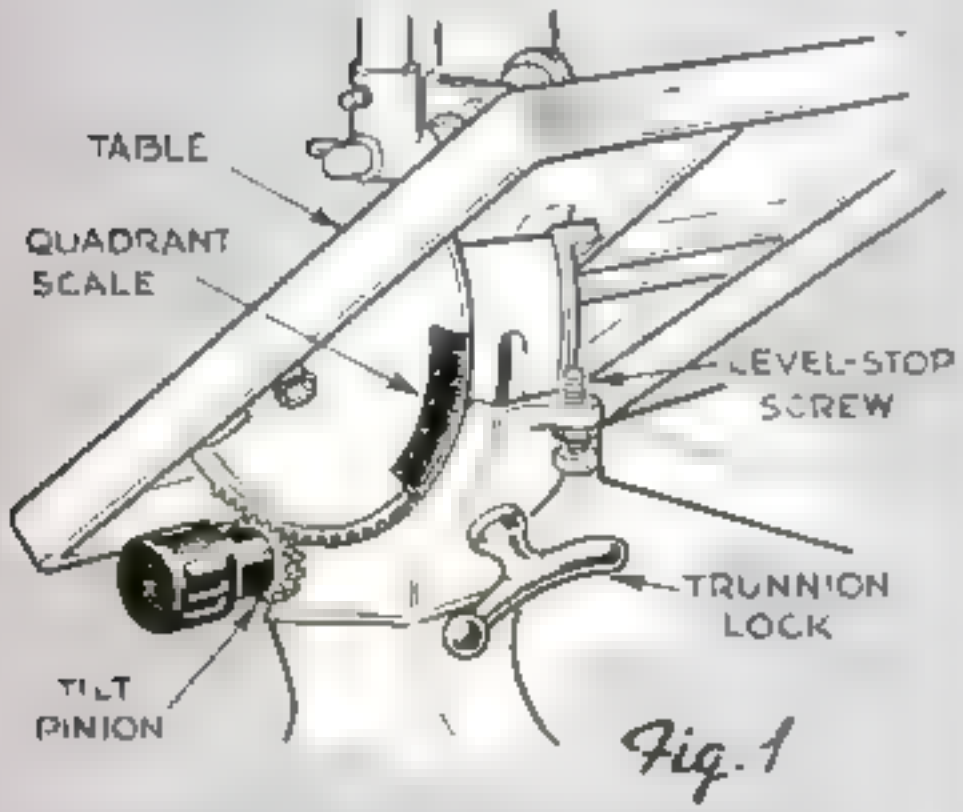


Fig. 1

TABLE WITH GEARED TRUNNION

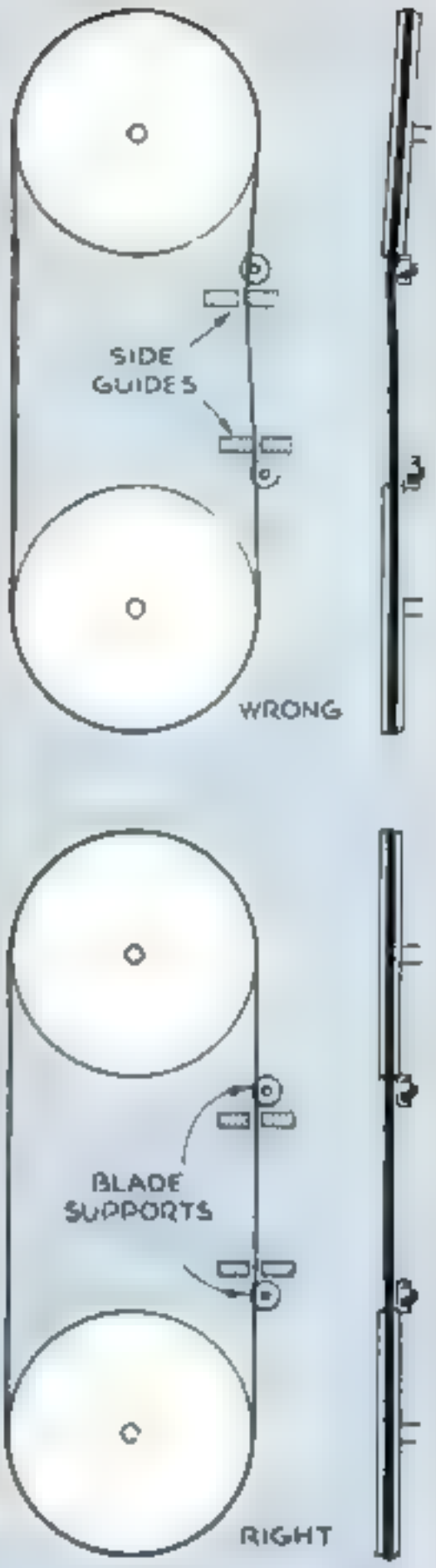
FOR rapid cutting of curves in wood, thick or thin, a band saw is the machine to use. Although it is especially adapted to cut outside profiles, inside cuts can also be made by sawing in from the outside, if the work is of such a nature that the entering kerf can be filled and puttied.

Since the beltlike blade moves uniformly in one direction, and at high speed, it cuts faster than the scroll saw. It will also cut much thicker stock—5" material can be sawed readily on most 12" band saws, and some larger home-workshop models will handle a thickness of 12". The main parts of a typical 15" band saw are shown in Fig. 1.

How is a blade installed? Remove the soft-metal table insert, the wheel covers, the table alignment pin, and, if necessary, the blade guards. Loosen the tension screw (Fig. 1) to lower the upper wheel. Back off the guide pins and roller blade support. Thread the blade through the table slit and loop it over the wheels, teeth pointing downward toward the table. Tighten the tension screw as recommended by the manufacturer for the width of blade used, or until the blade is drawn straight. Turn the lower wheel by hand to see if the blade tracks by creeping toward the crowned center of the rubber tires. If it runs toward either edge, turn the tilt screw slightly and try again. When it tracks properly, lock the tilt screw. Tap the table alignment pin carefully back into place.

What is the correct way to set the blade guides? Loosen the guide pins and move them toward the blade. There should be free sliding clearance on both sides of the blade (Fig. 2). Use a piece of heavy paper between the pins and the blade for a gauge. Lock the guides in their holders and adjust the latter until the fronts of the pins are even with or slightly behind the gullets of the teeth. Should the guides be carelessly set forward of this position, they will take the set out of the teeth and dull them. Adjust the back guides or rollers until they just clear the rear edge of the blade, so that they will make contact only under heavy cuts, for continuous rubbing tends to crystallize the blade and cause breakage. Replace the guards. The saw is now ready for use, but it should be started cautiously and shut off if the blade fails to track.

Band Saw



ADJUSTMENT OF GUIDES

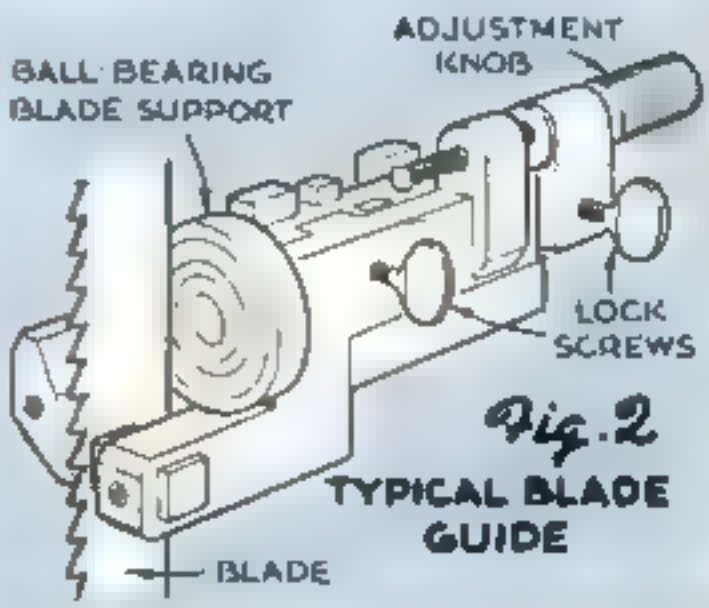


Fig. 2
TYPICAL BLADE GUIDE

Are any adjustments necessary on the table? Most tables are mounted on trunnions marked with a calibrated quadrant, and tilt from 5 deg. toward the left to 45 deg. toward the right. A stop screw, set by means of test cuts made on heavy lumber, levels the table accurately after it has been tilted. Some machines also have a stop screw for the 45-deg. position. Adjust the quadrant pointer to read correctly in these positions, so that it will mark intermediate degrees of tilt accurately.

How are simple curves cut on the band saw? Set the upper guide about ½" above the work, and saw with the teeth splitting the line and running in the waste wood. When the cut is to be sanded, allow a little stock outside the line. If the saw tends to "lead" to right or left, instead of sawing straight forward, make the necessary allowance in feeding the work. A blade that

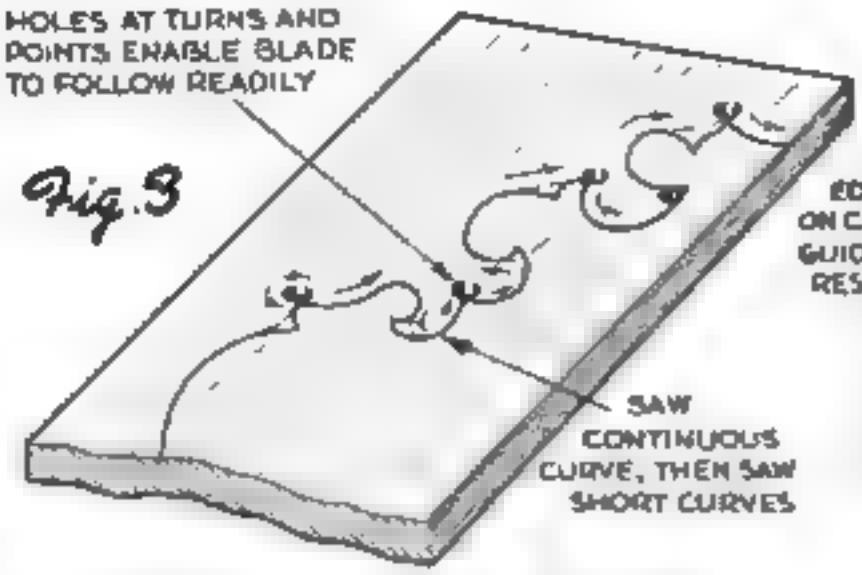
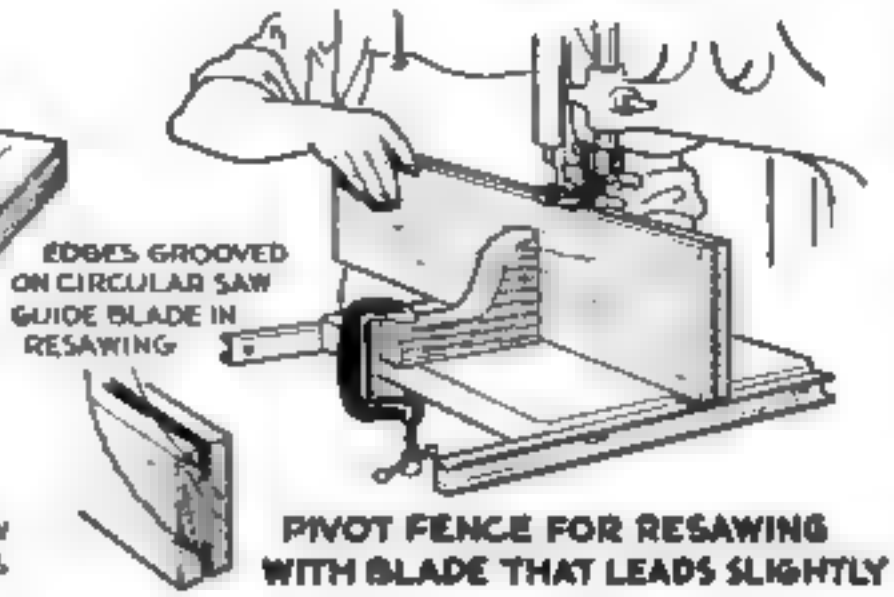
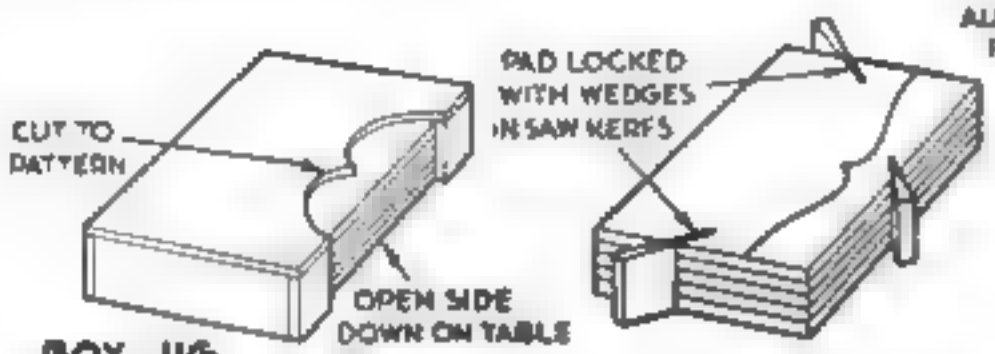


Fig. 3

BAND-SAWING INTERRUPTED CURVES



PIVOT FENCE FOR RESAWING WITH BLADE THAT LEADS SLIGHTLY



BOX JIG

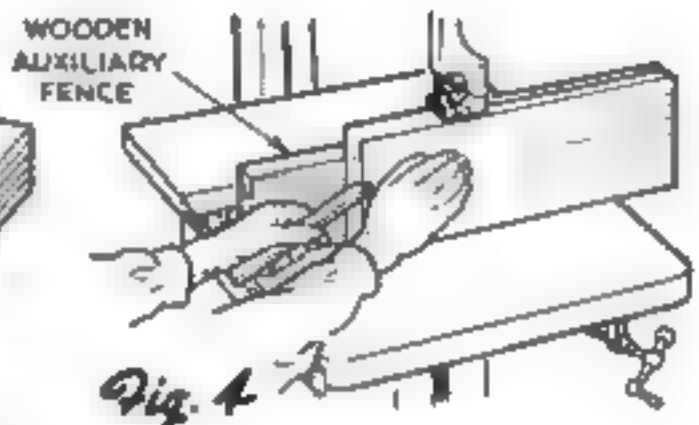


Fig. 4

RESAWING STOCK INTO THIN BOARDS

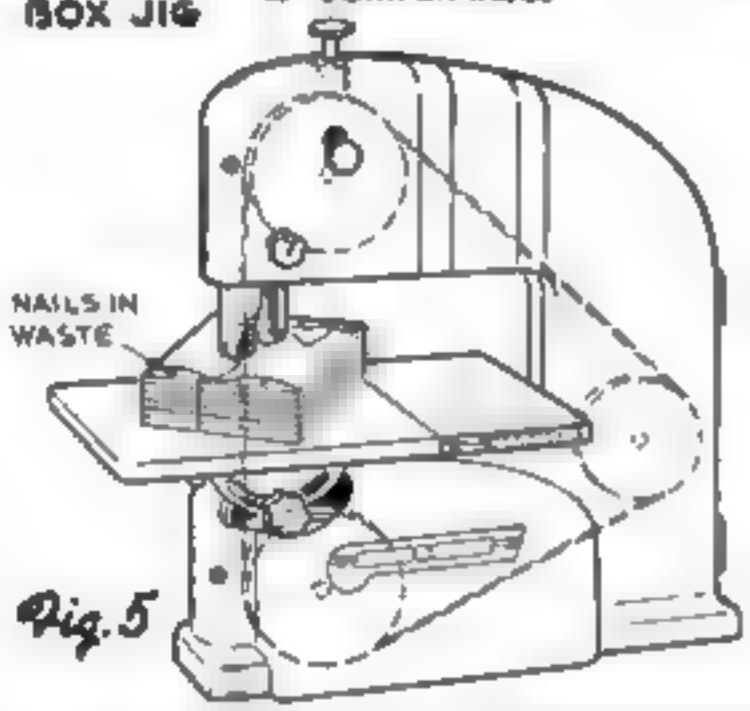


Fig. 5

MULTIPLE SAWING ON THREE-WHEEL BAND SAW

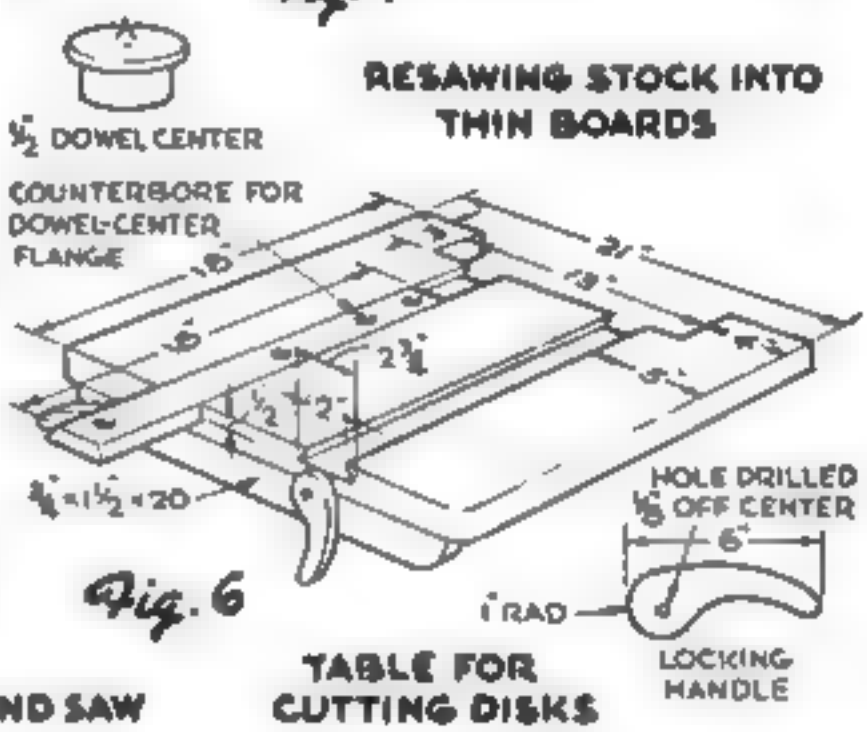


Fig. 6

TABLE FOR CUTTING DISKS

is sharp and properly set probably needs more tension if it weaves in the cut. Do not force the feed—a little experience will teach you what pressure is needed. Use one hand as a pivot, swinging the work around it; when the curve reverses, change hands accordingly. Keep the hands well out of the path of the blade, especially when it is emerging from a cut. As a rule, the blade should not be backed out of a deep cut.

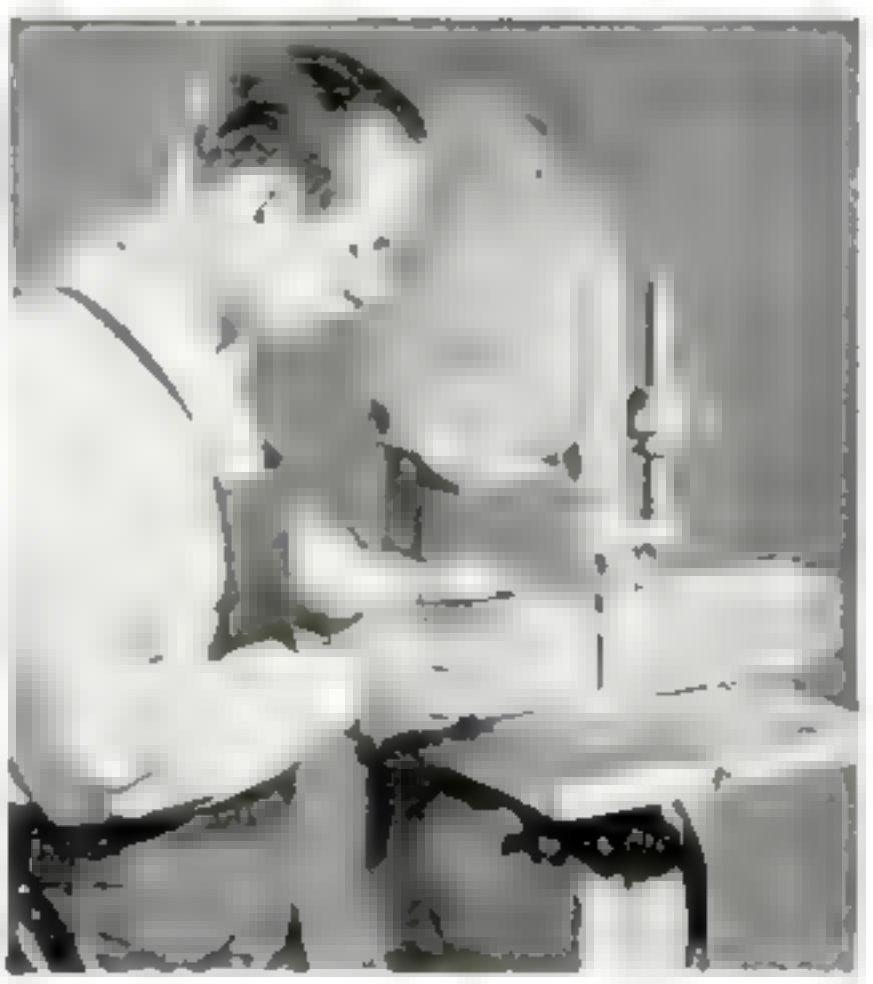
Can interrupted curves be cut? Yes. Follow the line until near the angle, but do not enter the latter. Instead, swing off in a sweeping curve that will carry the blade into the following part of the line (Fig. 3). After finishing the continuous cut, saw into the angles from both directions, starting to cut on a curve or straight section, with the side of the blade tangent. The blade can be safely backed out of a shallow kerf if the work is carefully handled.

Do thick pieces require special handling? The procedure is the same as for thinner material, but additional care must be taken to support heavy overhanging ends to avoid side strain on the blade. Use the widest blade that will negotiate the curves.

What is compound sawing? This is sawing a piece from two sides, as in shaping a cabriole leg. Square the stock and lay out the design on two adjacent sides. Saw one outline, tack the waste pieces back in place to afford a flat bearing on the table, and saw the other side. All nails should be driven on the waste side of the line.

Can ripping be done on the band saw? Some saws are fitted with adjustable ripping fences, but a strip clamped to the table will

In putting on a band-saw blade, lower the upper wheel to lessen tension. Turn the other wheel by hand after tightening. Adjust tilt, if necessary



Top, right, ripping corners from a turning square held against a fence clamped on a tilted table. Center, bevel cutting with the table at an angle. Bottom, compound cutting for a cabriole leg. The outline is drawn on two sides, and the second cut after waste from the first has been nailed back

serve the same purpose. Use the widest blade on hand, and if much ripping is to be done, have one filed especially for such work. This operation is especially useful for re-sawing 1" stock into thin boards. Use a high auxiliary fence if the stock is wide (Fig. 4). With a suitable cradle, billets can be sawed into veneer stock.

What is the method for duplicate work? Duplicate or multiple cutting is accomplished by stacking several pieces and holding them together by nailing, wedging, or clamping them in a box, so that all can be cut to one pattern at the same time. Figure 5 shows such a "pad" on the table of a three-wheel band saw, a type that affords large throat capacity yet requires little head room.

How can disks be cut accurately? A jig such as the one designed by James B. Leeth, of Birmingham, Ala., and shown in Fig. 6, is excellent for the purpose. The dovetailed slide should fit snugly. Eccentric clamps lock it in either groove. The work pivots on a ½" metal dowel center inserted in a suitable hole in the slide and centered on the points of the teeth.

IMPROVE YOUR MARKSMANSHIP

Homemade Clay-Pigeon Trap

Good sport in the field can be had with this simple equipment

By OWEN S. CECIL, JR.

BY CONSTRUCTING this inexpensive clay-pigeon trap, you can improve your marksmanship and give yourself and your sportsmen friends many hours of enjoyment shooting at the flying targets.

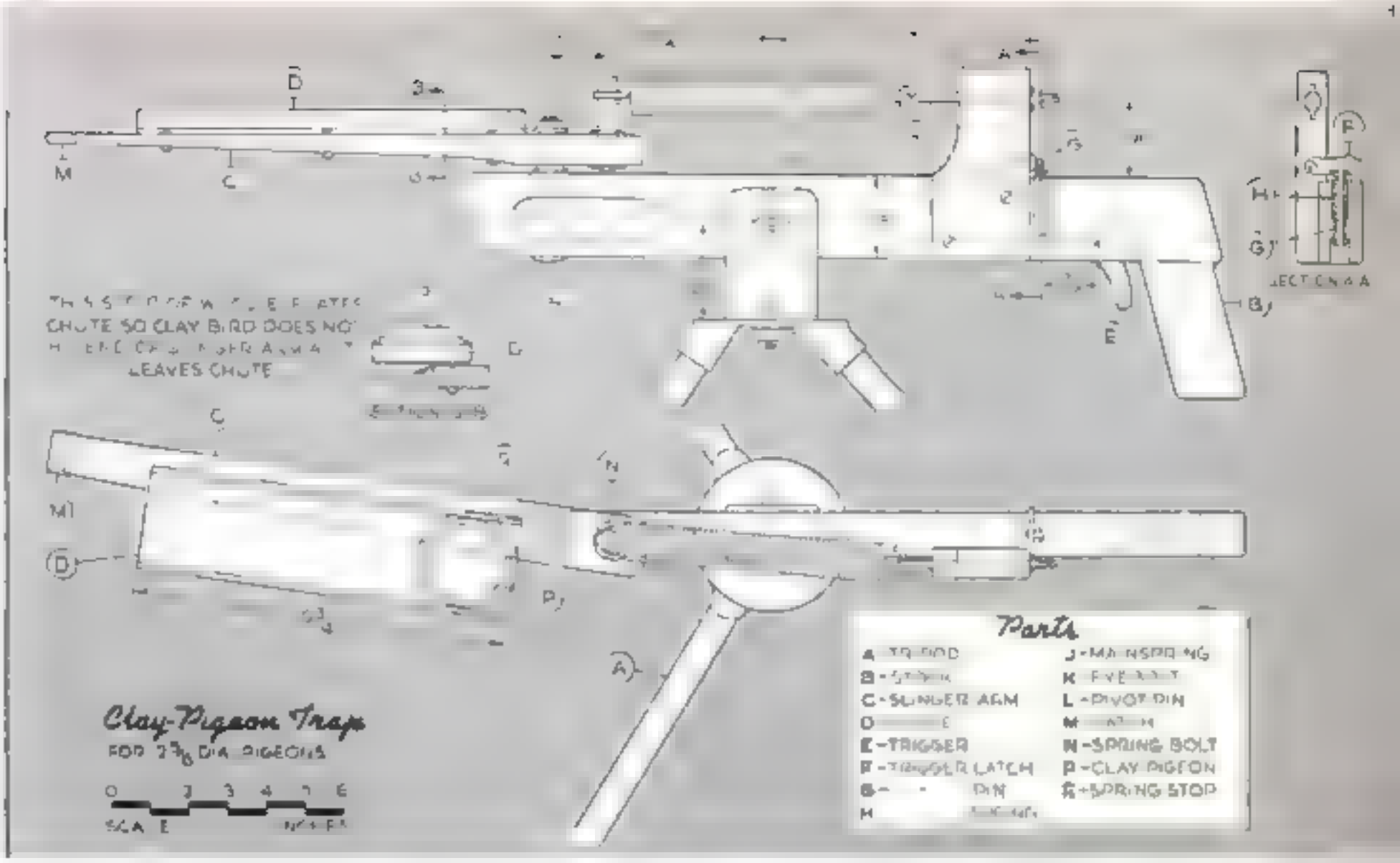
The trap is designed for the so-called "junior size" clay pigeons. These are 2⅝" in diameter and retail for a little more than half a cent each, which is approximately half the price of the larger regulation clay birds. A .22-caliber shotgun, which is like a .22-caliber smooth-bore rifle, is usually used for shooting at the small pigeons, and the cost per shot is kept down in this way to about a cent and a half for both shell and pigeon.

The trap may be used on a tripod as shown in the accompanying illustrations, or it may be held in the hands. By using the trap without the tripod and shooting it from the hip, clay pigeons may be thrown quickly at unexpected angles, and still greater skill will be required to break them.

The stock of the unit is made from a piece of oak 1⅛" by 2⅛" and is mortised at the end for a pistol grip, which is securely glued in place. The post carrying the main spring is cut from ⅝" oak, and the side of the stock is notched ¼" deep to receive it. The post should fit snugly in its recess, where it is glued and screwed firmly in position. The front end of the stock is then rounded off and grooved to provide a finger hold.

The mainspring measures 1" in outside diameter, is wound from ⅛" wire, and is 7" long from end to end of the coil. A spring of this type may be purchased in most well-stocked hardware stores. With this spring, the slinger arm has a stroke of 1½", and the spring is stretched 3" when the trap is cocked and ready to shoot. If a slightly different spring should be used, the length of the stock and the stroke of the slinger arm may have to be altered somewhat to cause them to work efficiently.

The slinger arm is made from a piece of fir or spruce and is tapered on one end. A brass bushing is pressed into it where it

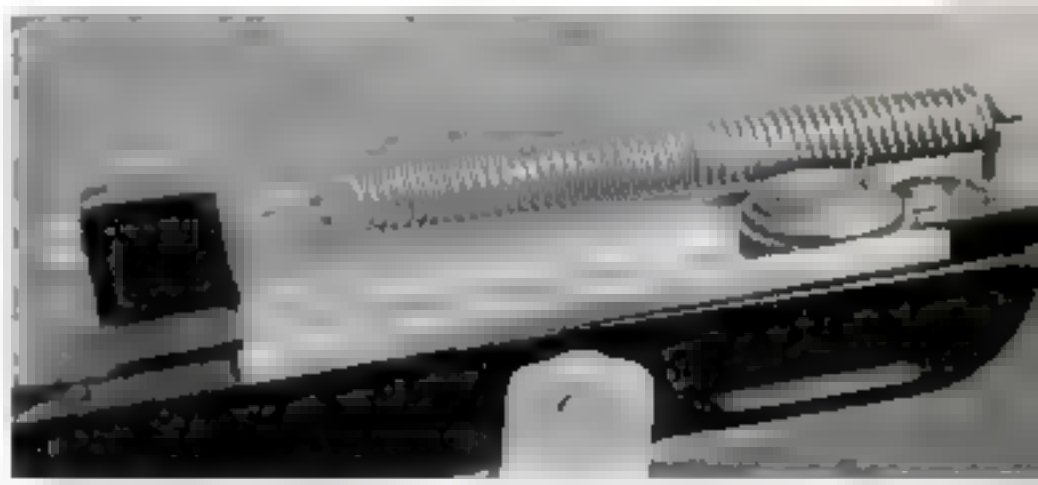


rotates about the pivot pin. The chute is bent from a piece of light-gauge tin and is bolted to the slinger arm with flathead 6-32 machine screws. The chute should be of such size that a clay pigeon will roll freely in it

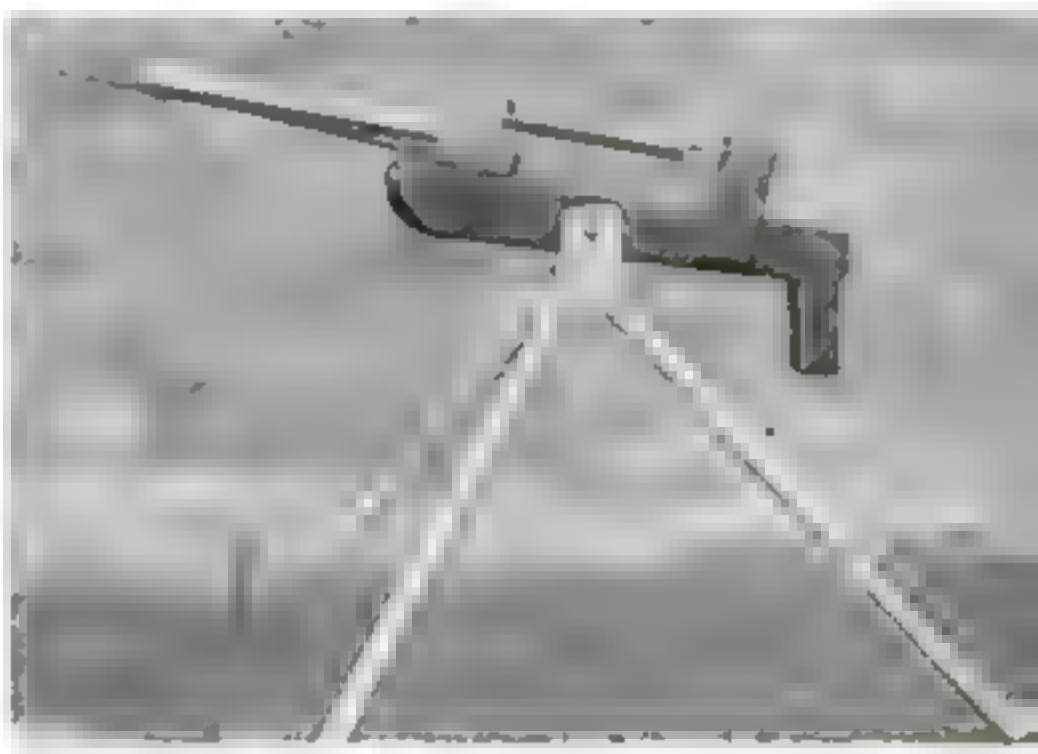
The clay bird is held lightly in the chute by a spring stop, which is a small piece of clock spring riveted in place. The spring bolt is a ½" steel rod with a groove turned in its upper end to take the loop eye of the mainspring. It fits snugly in a hole in the slinger arm, and the lower end is peened over a washer. It is important to have the slinger arm and the chute mechanism as light as possible so that the mainspring will snap the slinger arm out quickly when the trigger is pressed.

The catch on the slinger arm and the trigger mechanism are illustrated in the accompanying drawings. The trigger is cut from ⅛" steel and fits in a slot mortised in the stock. The tripod is made by brazing three ½" pipe couplings, cut off at a 45-deg. angle, to a steel plate 4" in diameter. Three 20" lengths of ½" pipe are screwed into the couplings to form legs. When these legs are removed, the trap forms a compact bundle for packing in a small space.

Care should be exercised when shooting the trap to be sure that no one stands near the slinger arm, as it swings around with great speed and force when the trigger is pressed.



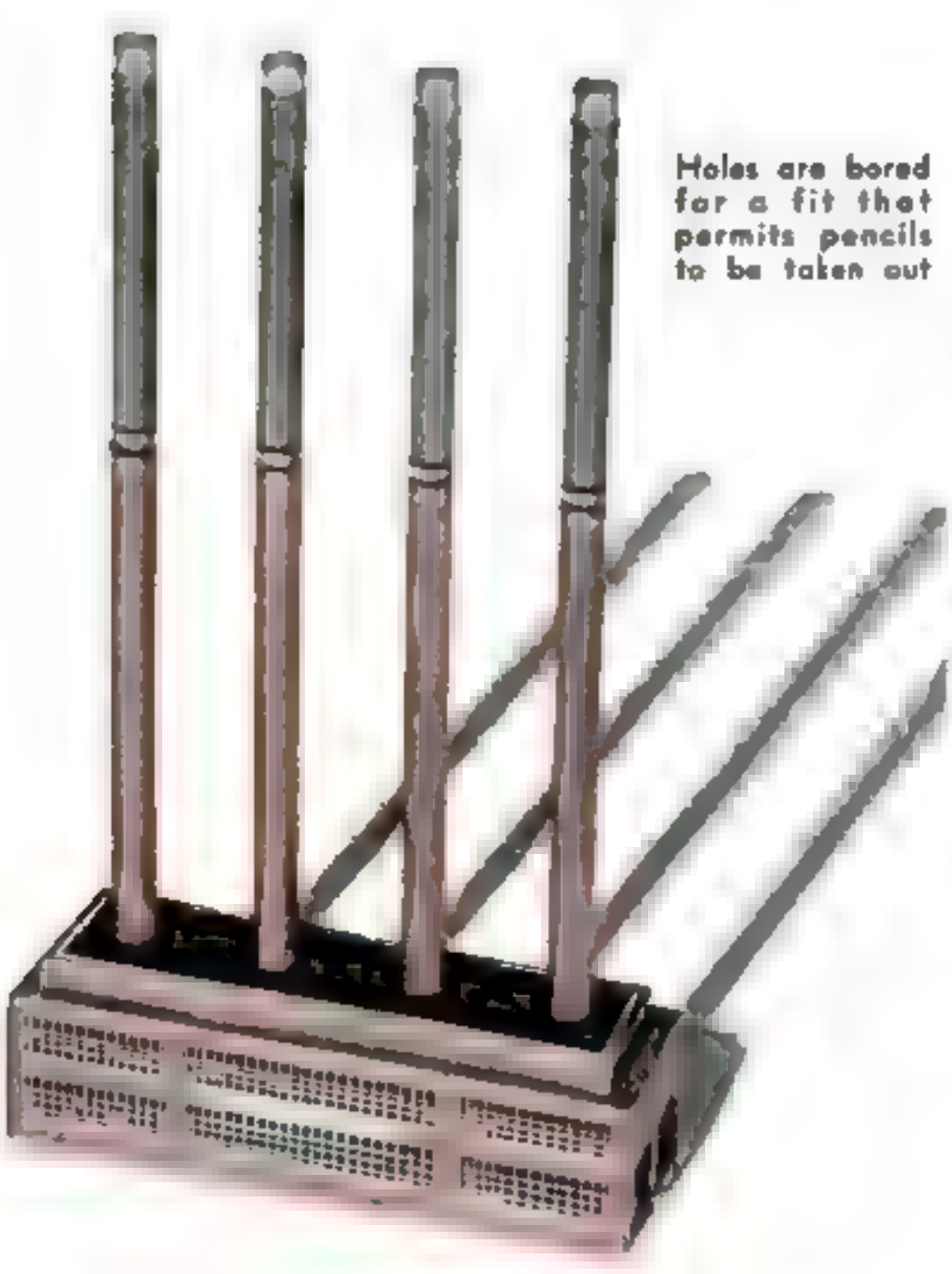
Above, close-up of the trap's firing mechanism, slinger arm cocked, a clay pigeon in place, and mainspring taut. Below, a general view of the trap on its tripod with the mechanism released. When the three pipe legs are unscrewed from the head everything can be made into a compact bundle



Toys, party favors, or desk accessories that catch the eye and fancy are made from tiny bits of scrap and pencils

Pencil Novelties

By MYRON FLEISHMAN
Toy and Game Designer



Holes are bored for a fit that permits pencils to be taken out

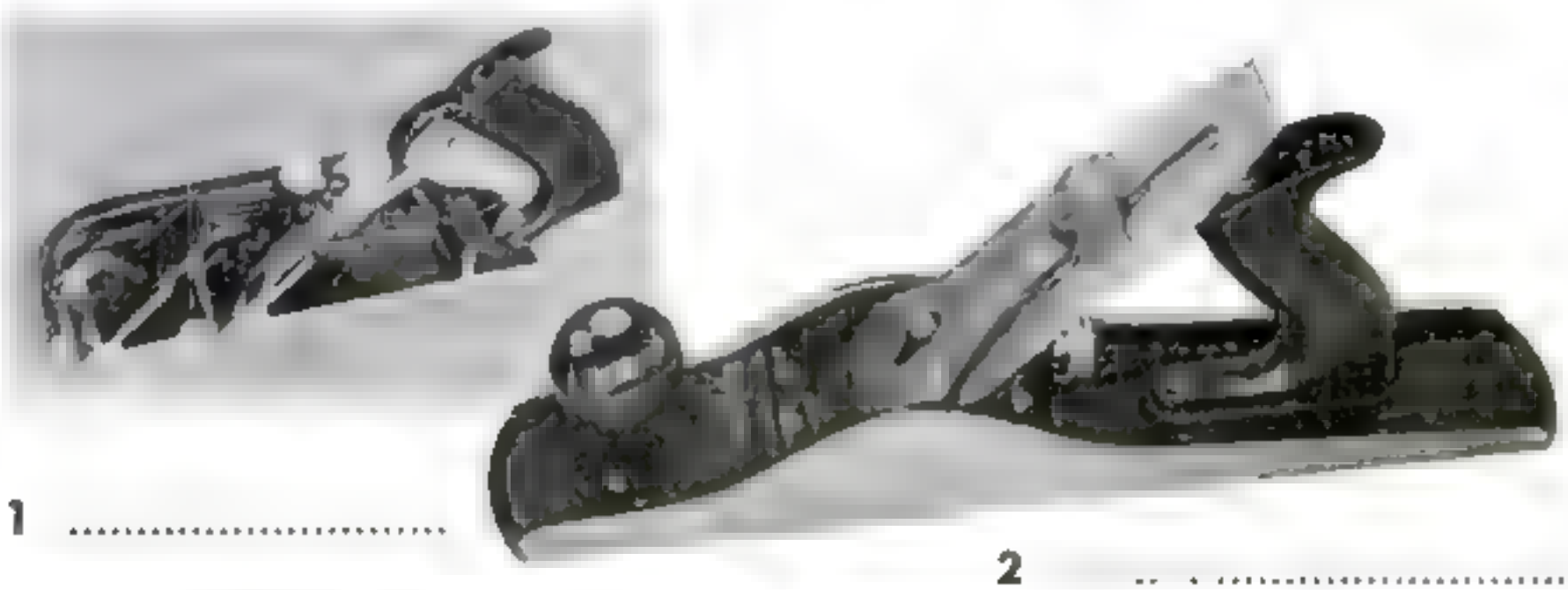
CHILDREN are fascinated by these colorful pencil toys. They also make amusing party favors or desk accessories, even for adults. If the craftworker will use his imagination, he can turn out special designs, such as the bristling cat, that are appropriate for Halloween and other festive occasions. Figures can be copied from magazines, comics, children's paint books, and various other sources.

Round or hexagonal pencils, bits of dowel, scrap wood, and wooden wheels from discarded toys are the only materials required. If small wheels are not available, slices sawed from a dowel will serve. The traffic-signal and lamp-post bases are turned or whittled. Sheet metal is bent to shape for the street sign, painted blue, and lettered in white. Disks of colored paper form the traffic lights.

Olive drab is the approved color for the cannon. Four tall stacks lend an amusing touch of exaggeration to the factory, which is painted bright red and has black windows crosshatched in white. The smokestack pencils are gray for 2½" from the top, and red below. Use a bright color for the carpet sweeper.

Question Bee

PLANES were used by the Romans before the fourth century A.D. One type consisted of a wooden core faced with iron on the sides and bottom—forerunner of the modern all-metal plane, of which nine varieties are illustrated below. These include an adjustable rabbet plane with depth gauge, a duplex rabbet plane, a groove plane, a tonguing and grooving plane, and a model maker's curved-bottom plane. See if you can identify them all and write the names on the dotted lines. The answers appear below.



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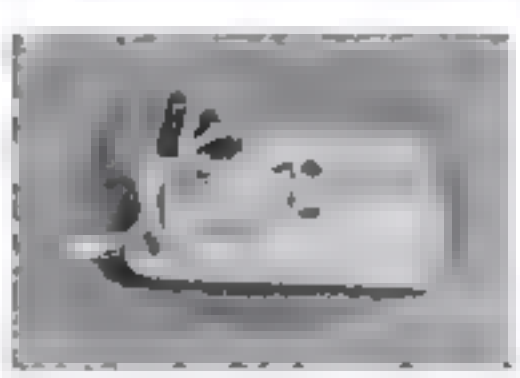

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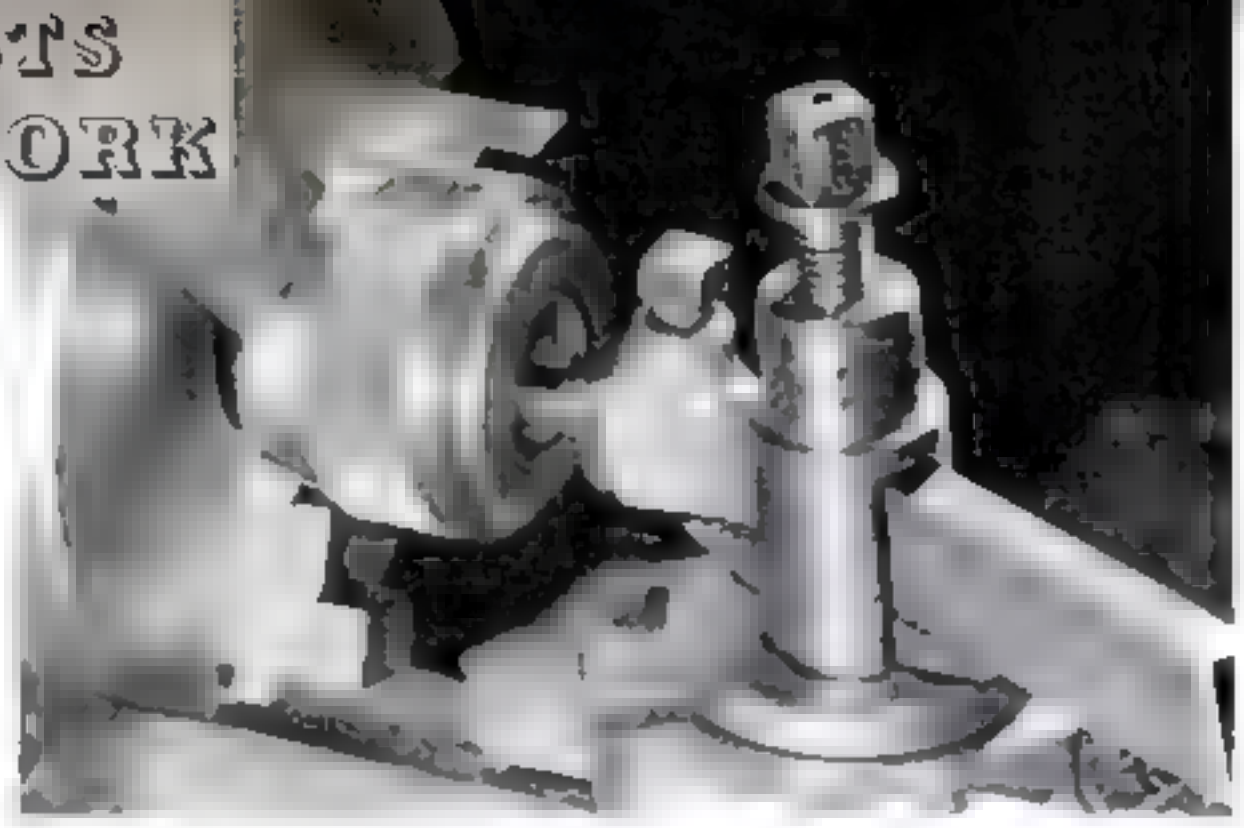
ANSWERS

1 Duplex rabbet plane 2 Adjustable rabbet plane with depth gauge 3 Tonguing and grooving plane 4 Adjustable rabbet plane and grooving plane 5 Groove plane 6 Adjustable block plane 7 Half-nose rabbet plane 8 Model maker's plane with curved bottom 9 Low-angle block plane



HEAVY-DUTY

Lathe Tool Post

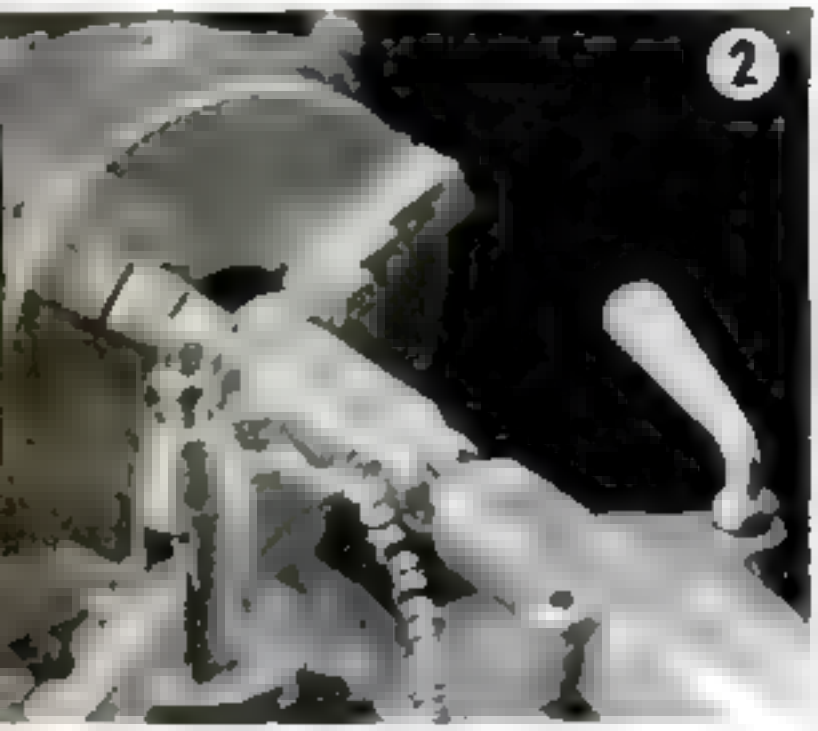
By C. W. WOODSON

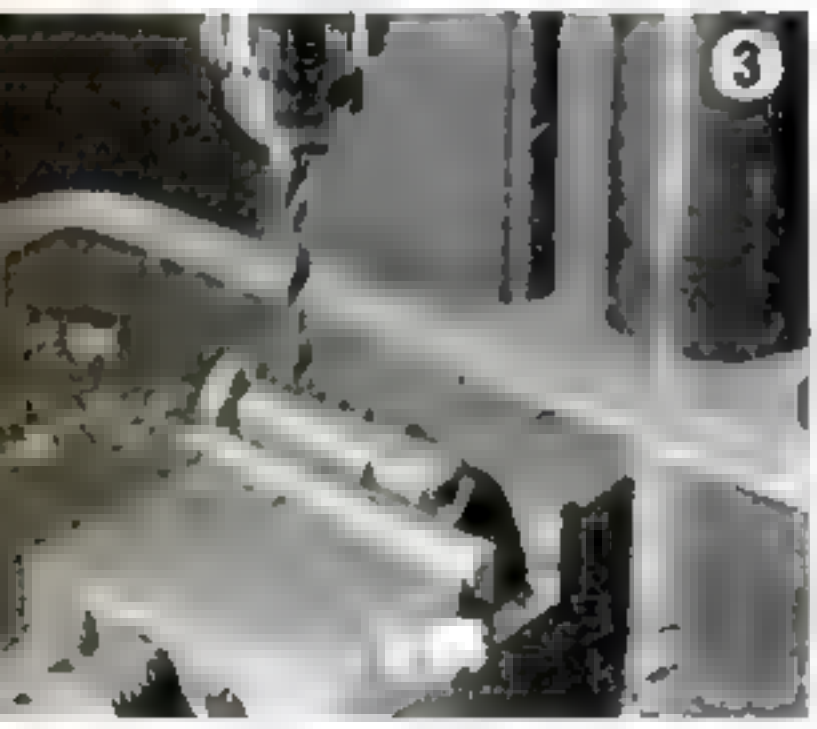
AN EXTRA tool post is often needed for use in a double tool slide. The one shown in Fig. 1 is designed to withstand the enormous stresses of heavy cutting operations. For maximum toughness, it is best to make the various parts of tool steel, which can be hardened and tempered. The dimensions in the drawings can be changed to suit any lathe.

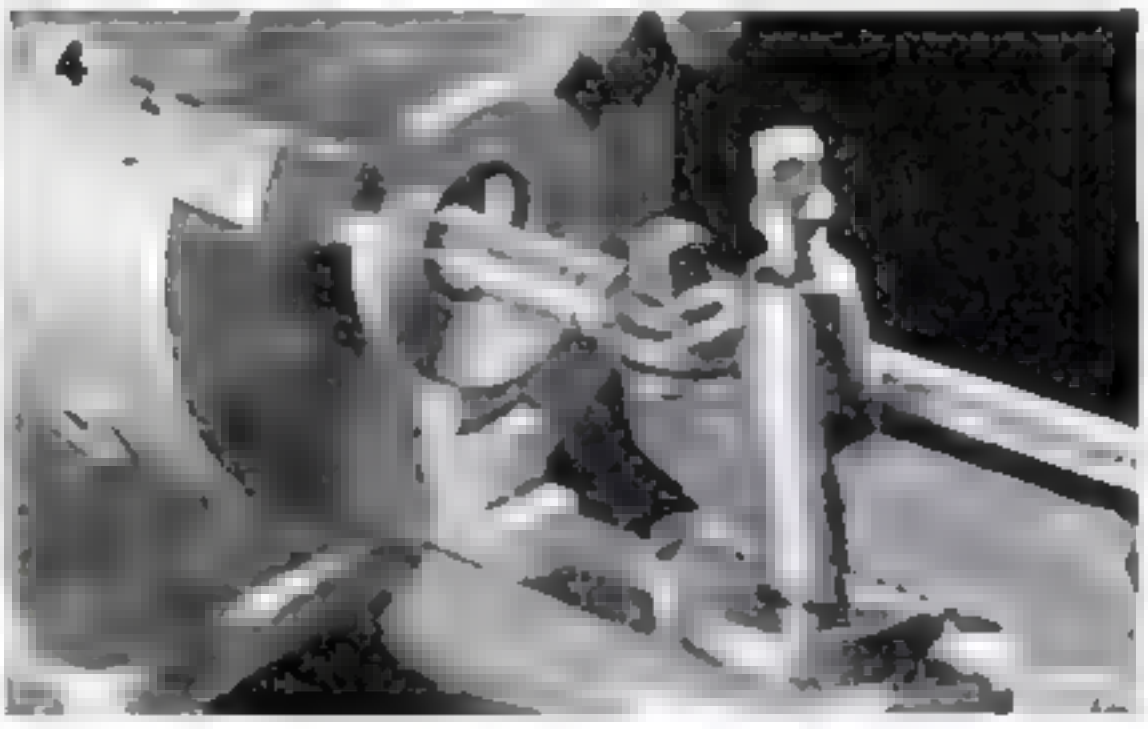
A short bar is first chucked as in Fig. 2 and turned to size for the body. The hole for the screw is drilled and tapped while the piece is held in this position, and the work is filed smooth and polished.

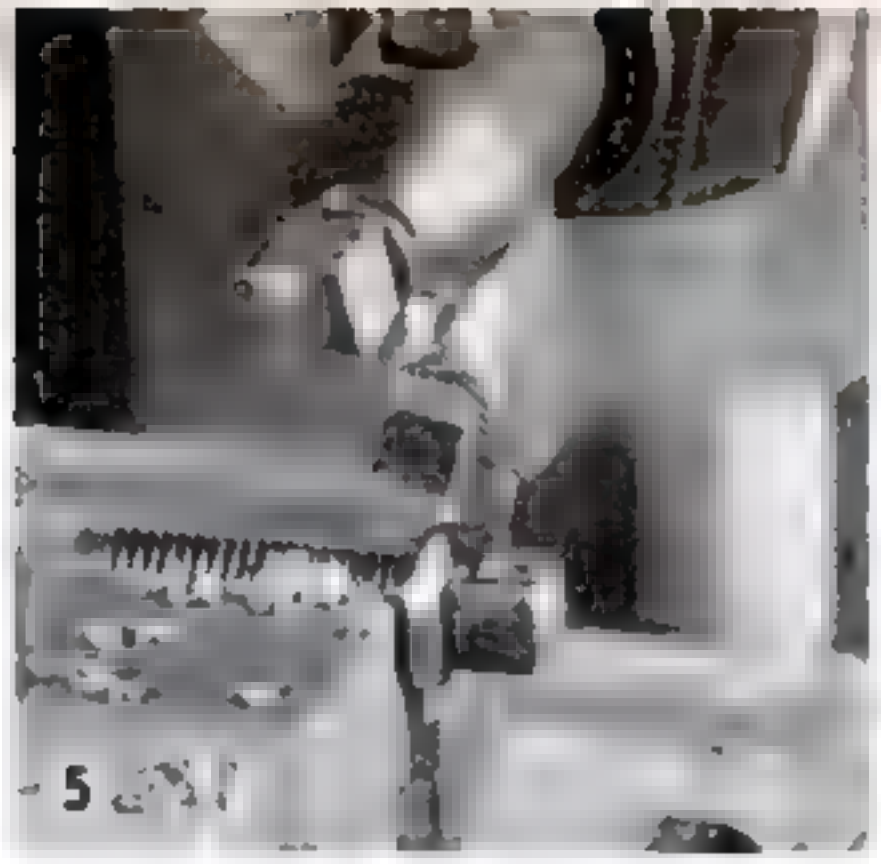
It can then be clamped in the drill-press vise so that a series of holes may be drilled (Fig. 3) as the first step in cutting the rectangular opening. The metal between the holes is chipped away with a cold chisel and the opening then filed to exact shape and size.

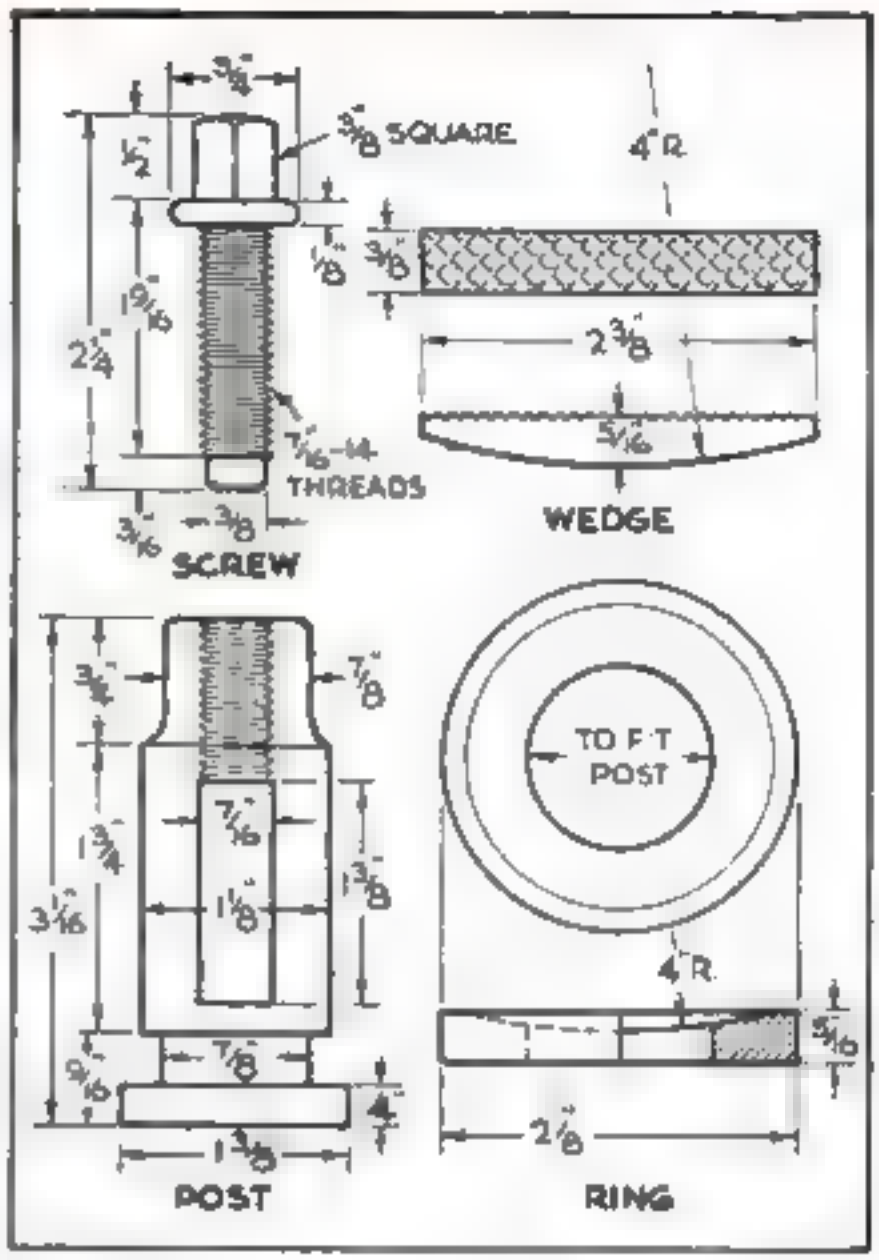
The tool-post ring is turned from a thin steel disk chucked as in Fig. 4. Bore the hole to an easy fit on the tool post. Saw the wedge or rocker from a ⅝" bar and grind it to shape on the bottom. A series of grooves filed











across the top will offer the tool holder a firmer grip.

The screw is turned from ⅝" rod and threaded in the lathe. Its square head can be cut in the shaper as in Fig. 5, formed in the milling machine, or filed to shape by hand.

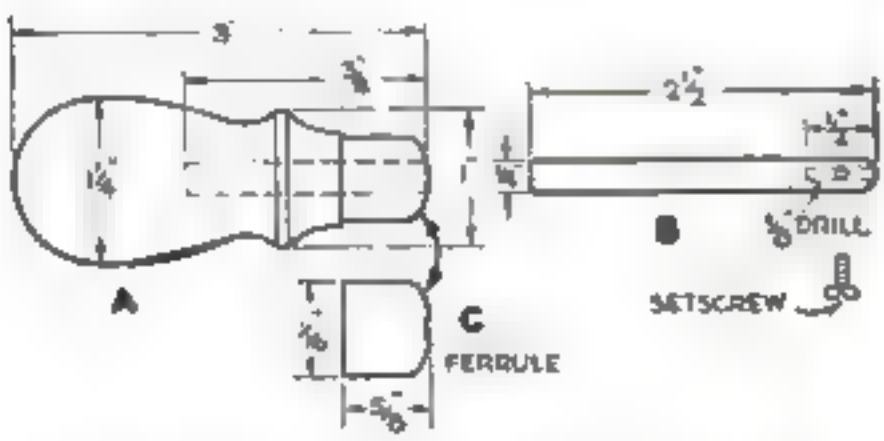
The tool-post ring, wedge, and screw are all hardened by heating to a cherry red and quenching in oil. Burn off the oil and quench again. Repeat until the parts are tempered.

Set of Special Cutting Tools Forged from Drill Rod

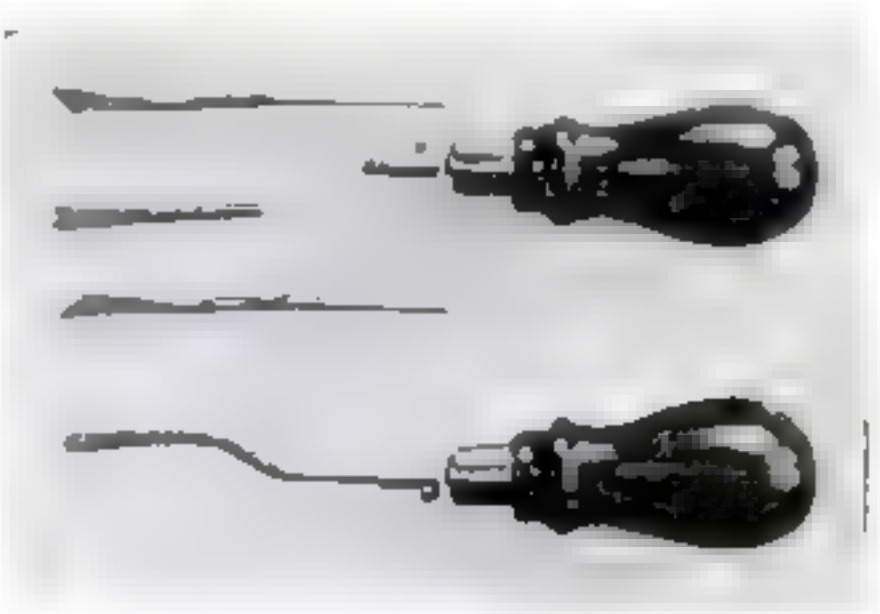
AN ASSORTMENT of small, keen blades and one or two holders will be found useful for close work in cutting, carving, scraping, and model making. Those shown are for carving statuettes and finishing art castings. The ½" squares give an idea of their size. For linoleum print-block cutting or pattern and model making, other types may be desirable.

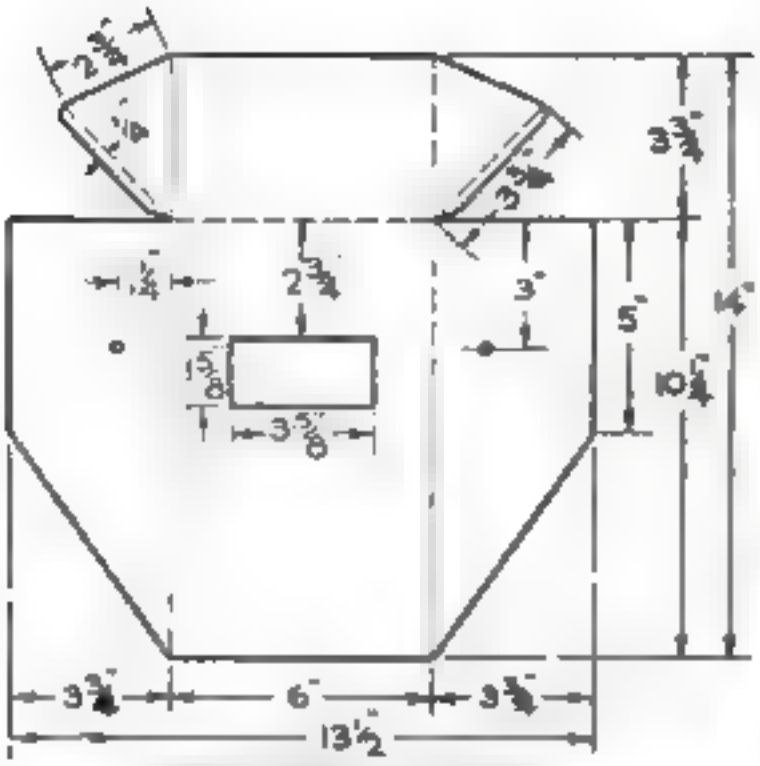
To make the blades, cut drill rod to suitable lengths and bend as required. Heat the cutting end to redness and flatten by hammering. A block of iron clamped in a vise will serve as an anvil. Reheat the end as often as necessary, and when it is sufficiently flattened, cool in the air. File to shape and bevel the cutting edge roughly. Temper by heating the blade to redness and plunging quickly into cold water. If the result is too brittle, the temper may be drawn slightly by holding the blade in the flame of a match or a candle for a few seconds and cooling in the air. Sharpen on a medium silicon-carbide stone and finish on an oilstone. Properly tempered blades take a razor-keen edge, and may be resharpened as necessary.

The holder can be made for ⅛", 3/16", or larger shanks. The handle is turned from hardwood; the holder is round steel or brass stock, drilled at one end to take the tool, and cross-drilled and tapped for the setscrew. The ferrule may be taken from a discarded tool or obtained new. To set the holder in the handle, heat it, dip in melted rosin, and drive it in.—K. R. SIPPLE.



Handy carving tools may be shaped as at right or to suit special needs. A handle is turned and a metal holder drilled, as above, to take the tool





Rolled and wired edges give rigidity to the mask Notches at the corners make bending there smooth

Electric

By

MEN who are studying electric welding, as well as mechanics in small shops where an electric welder is available, will find it interesting and profitable to make their own welding masks. The one illustrated, although of simple construction, is of the adjustable type that can be raised off the face when not in use. This is an advantage because it leaves both hands free for welding operations.

The mask proper is made from a 14" square of light sheet tin. The flattened body of a 50-lb. lard can will serve nicely. Cut this as shown in the layout at the left, and solder the corner joints. To make the mask rigid, wire the outside edge, using 12-gauge iron wire. Cut a V in each corner before bending the tin around the wire

The dark glass used is a standard 2" by 4" arc-welding filter, shade 10. This is covered with a piece of clear glass as a protection against damage from sparks. The frame for the glass is of tin, bent to the shape shown and soldered to the face of the mask. Its bottom member is made removable so that the glass may be replaced if need be, and is held in place by three 6-32 machine screws, with the nuts soldered to the inside of the mask.

Make the head strap of ⅜" leather belting 18" long. The other materials required are: 1 pc. 1/32" fiber, 1" by 11"; 1 pc. 1/32" fiber, 1" by 5¾"; 2 pc. 1/16" fiber, ⅜" by 4½"; 1 pc. ½" leather strap, 10" long; 1 buckle, ½", and the necessary split rivets.

Tin shaped to hold the filter is soldered to the face of the mask

Riveted fiber and leather form the headgear. At right, supports are held with friction joints

Welder's Mask

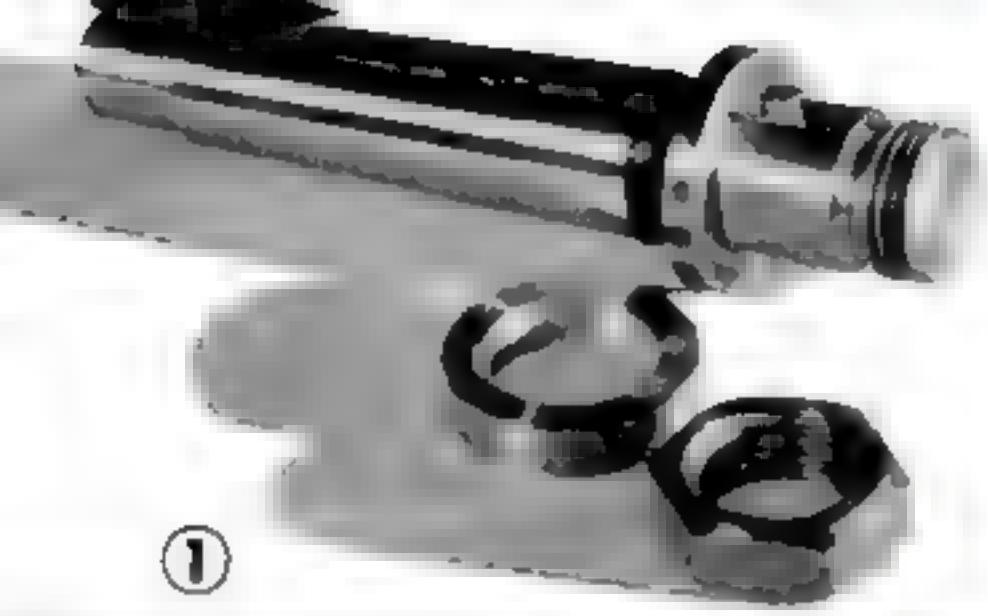
W. A. CONWAY

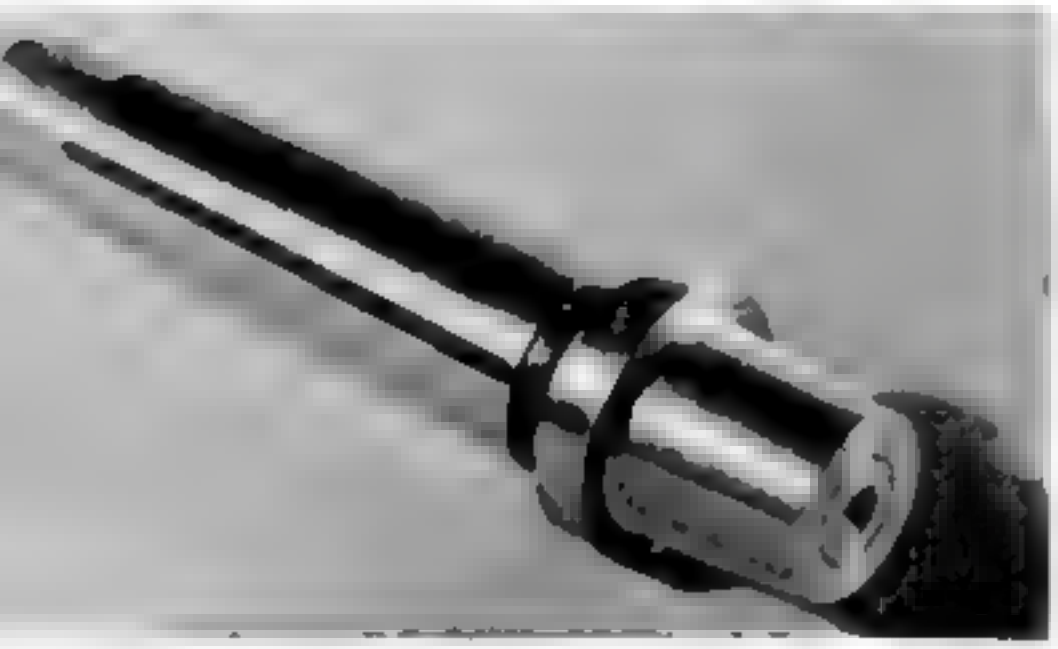
Bend the flexible fiber strips into smooth curves and fasten to the leather as shown with split rivets. If desired, elastic may be substituted for the leather adjusting strap in the back, and for all ordinary use will give good service.

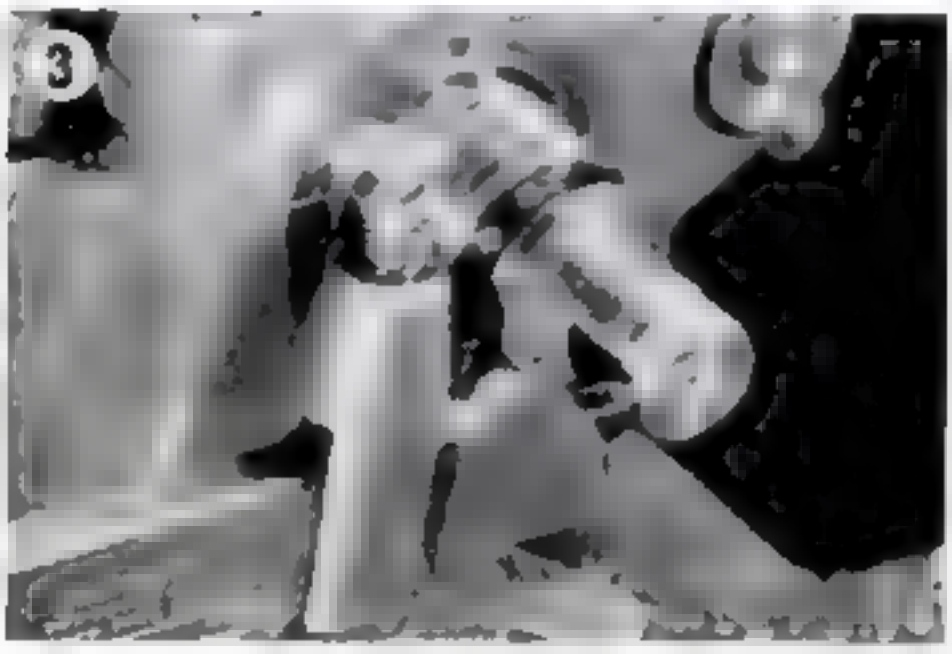
The mask is supported by two strips of 1/16" fiber 4½" long. A friction joint is made at each end by using a threaded washer or two 8-32 nuts, one of which is slightly larger than the other. These can be locked against each other to prevent loosening.

Paint the inside of the mask a flat black, and use a black wrinkle or crackle finish for the outside. This sort of paint is obtainable at radio supply stores.

The mask can be made also of 1/32" fiber instead of tin, in which case all joints can be fastened with small tubular rivets and, if desired, reinforced with small bent strips of tin. One advantage of fiber is its light weight, which might prove welcome if the mask is to be worn for long periods. If much close work is to be done, fiber may be more desirable than tin plate because it will transmit heat less readily







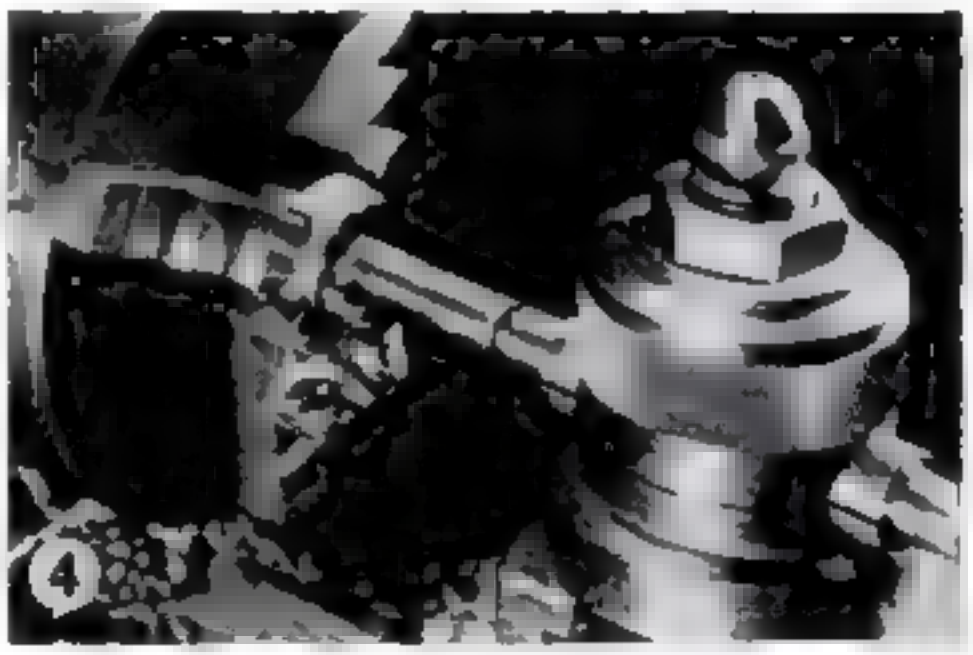
Drill-Chuck Shank AND Milling-Cutter Arbor

THE construction of these two useful lathe accessories will furnish excellent practice in taper turning. They are quite similar in most respects, the chief exception being that the drill-chuck shank is tapered as well on the outboard end to receive the drill chuck, while the milling-cutter arbor is turned straight on that end and threaded for a nut to clamp milling cutters in place. Both these tools, being subject to considerable abuse, should be made of 1" tool steel, which may be hardened if desired.

The tapers on the shank ends of both tools were cut in this case by the set-over tailstock method. The tailstock was adjusted gradually by means of trial cuts checked against a standard Morse taper test gauge until the proper taper was obtained. If a gauge is not available, the taper can be determined by scribing chalk marks on the shank and trying it in a taper socket. Twist the shank in the socket and note whether the chalk rubs evenly for the entire length. If not, return the shank to the lathe, reset the tailstock, and take another cut. When the correct setting is found, any number of pieces can be turned to the same taper providing the stock is all the same length, the center holes all the same depth, and the tool bit set at exact center height. Any variation will throw succeeding tapers off.

In making the two pieces, it will be good practice to rough-turn both to shape before cutting the shank-end taper of either. Then, after gradually bringing one shank end to the proper taper as described, remove that piece from the lathe and mount the other for tapering while the tailstock is still set. This will save much work.

The drill-chuck shank, shown in the lower photograph in Fig. 1, was reversed in the



CUTTING THREADS ON TAPERED WORK [*LATHE WORK*]

Two methods of setting the threading tool for cutting screw threads on tapered work are shown in the drawings above. That at the left shows the tool setting when a taper attachment is used, that at the right, the tool setting when the set-over tailstock method is used In both cases the outer edge of the thread gauge is applied to the parallel part of the work and the tool set at 90 deg. to this part. It is very important to have the tool bit set at precisely the same height as the lathe centers when cutting taper threads.

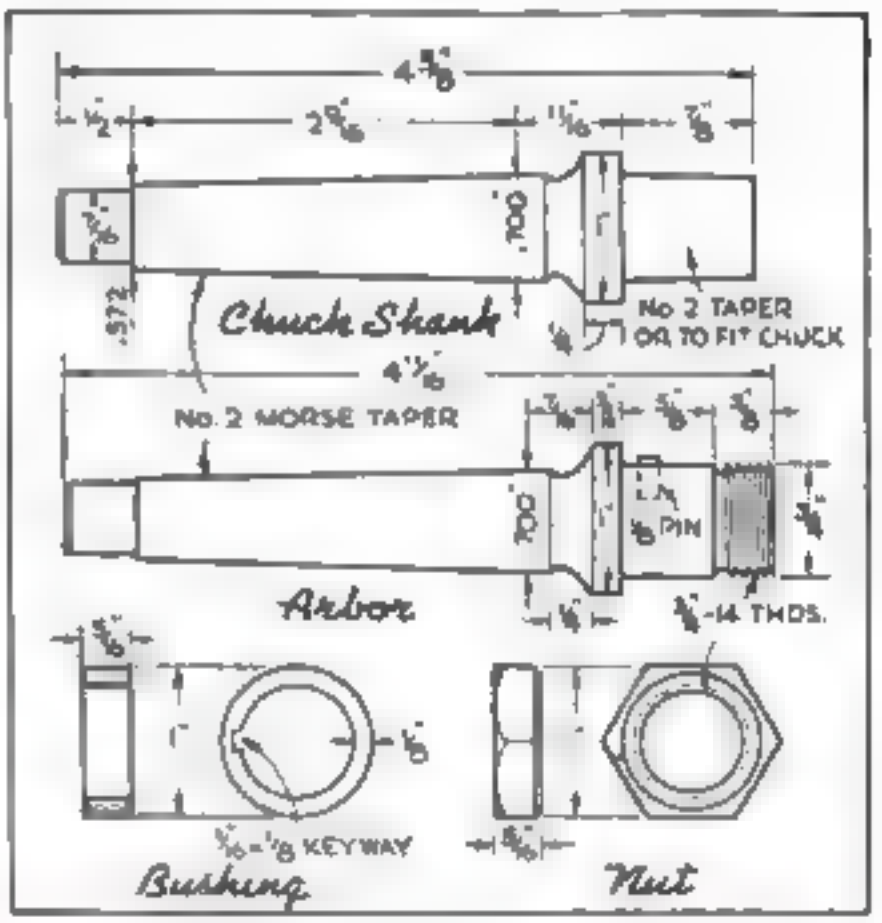
POPULAR SCIENCE MONTHLY SHOP DATA

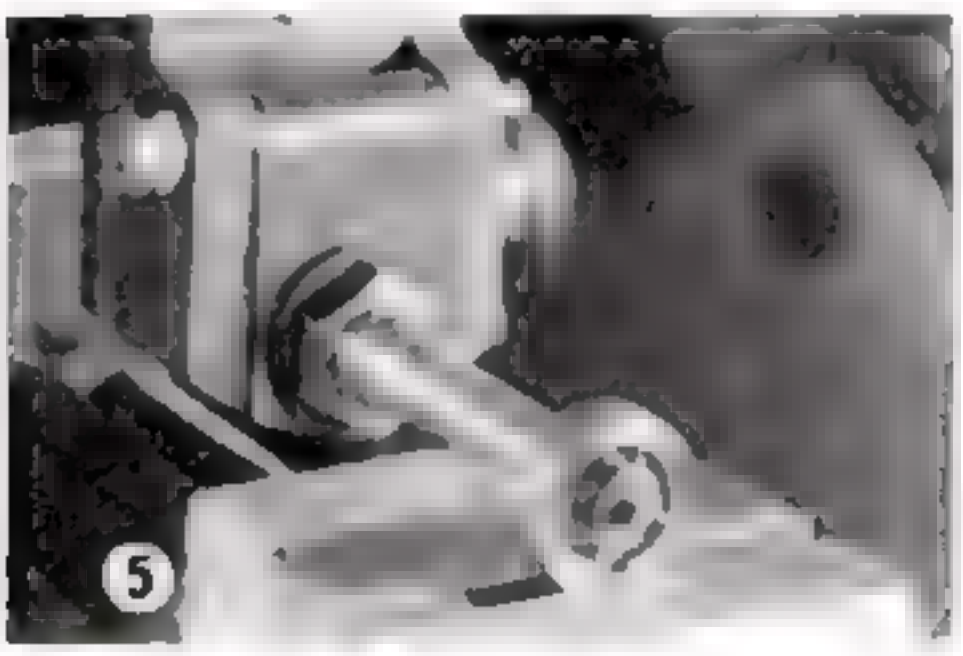
lathe after the shank end had been tapered, and the same taper was cut on the short end, as in Fig. 2, to be a drive fit in the drill chuck. However, this taper may vary slightly depending on the drill chuck with which the shank is to be used.

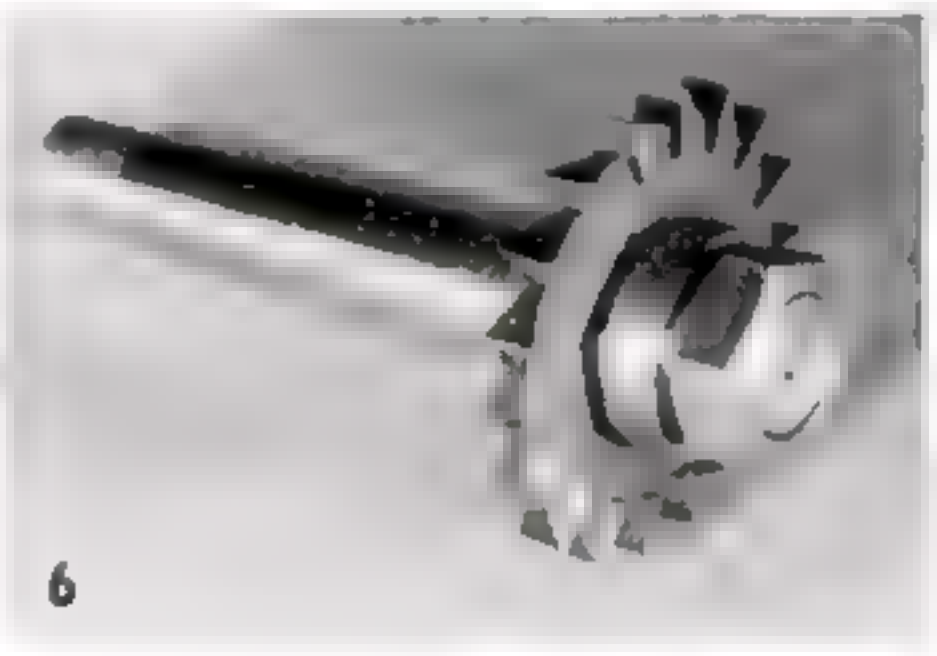
Then the milling-cutter arbor, shown at top in Fig. 1, which had also been taper-turned, was inserted in the live spindle, and the short end turned straight and threaded (Fig. 3) as specified in the drawings.

A hole for a small hardened pin, which serves as a key, was drilled and this pin driven in place. The clamping nut was made from a short piece of hexagon steel rod, drilled and bored as in Fig. 4 and finally threaded to screw onto the arbor.

To adapt the arbor for use with thin cutters, a bushing was turned and bored to dimensions and a keyway cut (Fig. 5) with the internal tool on the shaper. In Fig 6 the arbor is shown with a cutter mounted.







IMPROVE YOUR HOME NOW

Care used in laying out and grooving the stringers for treads and risers insures a stairway that will be sturdy

The ABC of

By JOHN MODROCH

IN MAKING extensive repairs to an interior stairway or in building a new one, the use of properly housed, or grooved, stringers is the best insurance for a sturdy and creak-proof job. The accompanying photographs show an interior wall-side stairway stringer housed in the approved manner.

Should the job be repairing or replacing a former stairway, the rise and tread will have been established. The rise is the vertical distance between successive treads, and the tread—sometimes called the run—the horizontal distance between successive risers. Note particularly that to establish the ratio between the two, the tread measurement ignores the nosing or projection of tread beyond the face of the rise.

If you are starting from scratch to build a new stairway, determine first the total rise, floor to floor, and the total run, which is the horizontal distance from the face of the bottom riser to the face of the top riser as shown at *A* in Fig. 1 (page HW 158). There is always one less tread than riser.

At *B* in Fig. 1 are shown comfortable measurements for rise and tread. For your particular problem they probably will not work out to exactly these dimensions. In any case, twice the rise plus the tread should equal about 25". To determine the number of risers, divide the total rise by the standard 7⅝" . As indicated at *C*, the total rise of 104" gives us 13 risers with space left over. So we could build the stairway with either 13 or 14 risers. If we take 13, we divide 104" by 13 and have 8" as our riser height. To get proper headroom above, and the right location of our bottom step, we have about 110" as the total run. Dividing this by 12 (one less than the number of risers), we find that by using 109½" for the total run we get 12 treads 9⅛" wide. This 8" rise with 9⅛" tread is pretty close to our standard formula.

Stringers fastened to the wall, the stairway is built from top to bottom with the work done from underneath. At the right, a tread, fitted into its groove, is being tightly wedged

Narrow, tapered strips, as shown below, are glued and wedged under the treads and behind the risers. The grooves in the stringers are laid out with the aid of two templates

Stair Building

To groove the stringers, lay out the saw cuts as shown at *A*, *B*, and *C*, Fig. 2. Begin this by drawing a base line 1¼" from the lower working edge of the stringer, which should be given a true straight edge, as the accuracy of the layout depends upon it.

Then measure off the rise on the tongue of a carpenter's square, and the tread on the blade, adding the allowance for the base line in each case. Lining up these two marks, clamp the square between two straight-edged wooden strips locked together with screws.

The outside guide lines for the cuts of each successive step can then be laid out simply by sliding this marking jig from position to position, using the 1¼" line as the base, as at *A*, Fig. 2.

To lay out the inside guide lines (*B*, Fig. 2), cut two templates of wood—one for the rise and the other for the run. Make the first equal to the thickness of a riser plus a wedge, and the second equal to the thickness of one tread plus that of one wedge.

Cut the wedges to a taper measuring ⅛" at the small end and ½" at the large, and make those for the treads about 2" longer than the tread width. Finally, lay out the cuts for the nosing by extending the tread thickness the distance required, as at *C*. Because of a variation in the nosing curvature of mill-run tread boards, the best results can be had by giving each nosing cut and its corresponding board a number and then fitting them individually.

Start cutting the grooves by gouging out the nosing cuts after first boring small holes ⅜" deep to serve as pilots. Then saw on the guide lines to this depth. If an ordinary backsaw is used for this purpose, take extreme care not to overrun the nosing cuts and thereby mar the work. However, by using a stair builder's saw (shown at *D*, Fig. 2), which cuts on the pull stroke, this danger can be eliminated. Such a tool can be made easily, if a commercial one is not

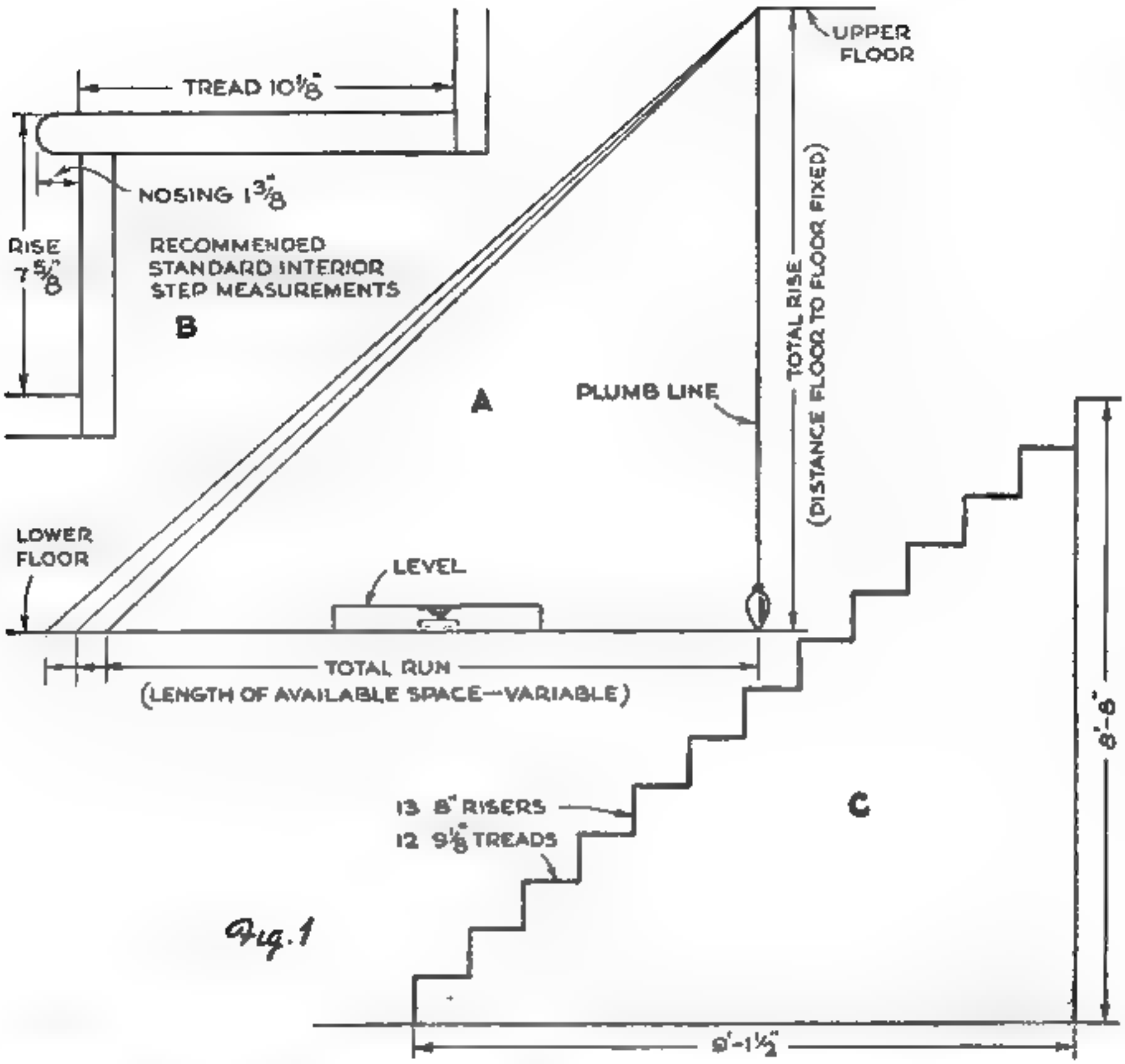


Fig. 1

available, from a broken rip or power hacksaw blade by mounting a 6" length of the blade in a slotted board shaped to provide a comfortable grip. Complete the grooving by cutting out the waste stock as at *E*.

Where space does not permit an assembled stairway to be moved into position, it must be assembled on the job. If it is flanked by walls on both sides, proceed as follows

First, install the stringers in position on the walls. Next, slide the risers and treads into the stringer grooves from below. Apply glue to the wedges and drive them into place. Then, from the back, nail through the risers into the treads and, from the top, nail through the treads into the risers as shown at *F*, Fig. 2. Use finishing nails for the latter, and countersink the nailheads. If desired, glue blocks may be applied underneath to reinforce these joints.

In case the stairway can be assembled beforehand and installed as a unit, it is possible also to nail through the stringers into the risers and treads. Opportunity to do this should, of course, be taken advantage of when building an open-sided stairway such as the basement job shown in one of the photographs.

Somewhat the same results can be obtained, so far as strength is concerned, in assembling wall-side stairways on the job by toenailing through the treads and risers into the stringers from below. If the stairs fit snugly between the walls, this extra nailing is not essential. Even if the wedges should in time work loose, the resistance of the walls would prevent the treads from falling out of the grooves.

Pine is usually used for making the stringers and risers, but oak or other hardwood, because of its better wearing quality, is preferable for the treads. Ordinarily the thickness of the stringers is made to match up with the thickness of the hallway baseboards in order to secure a flush joint where the stringer ends and the baseboard begins.

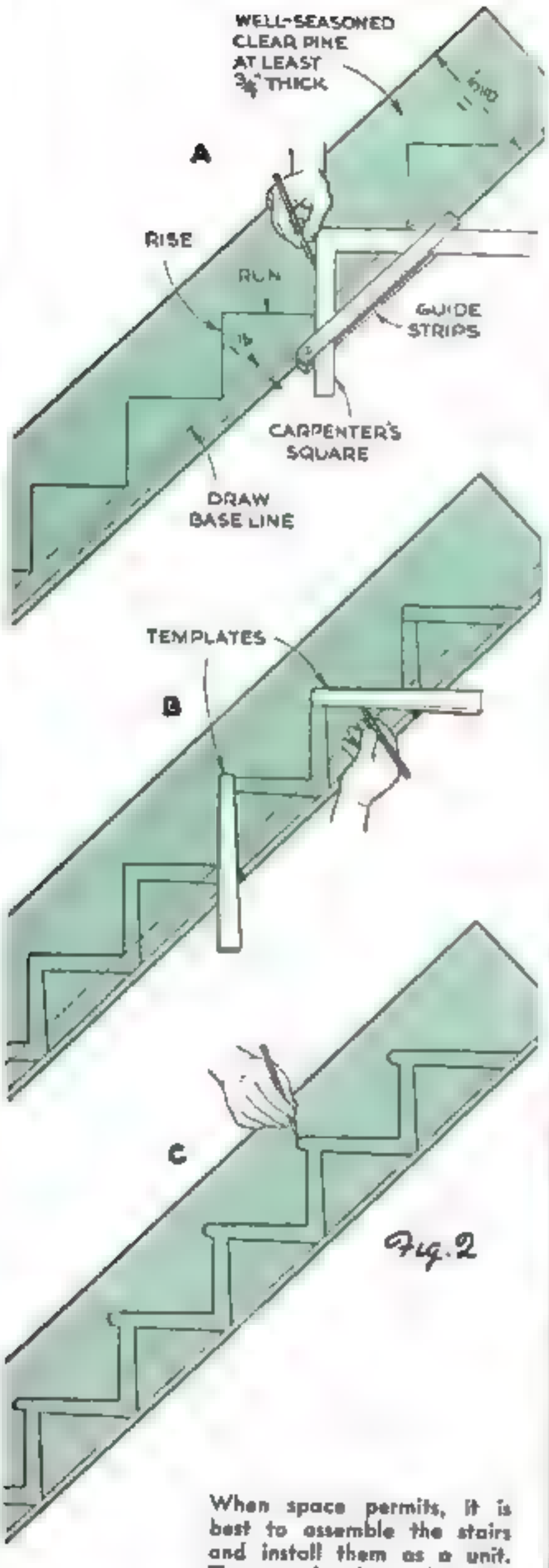
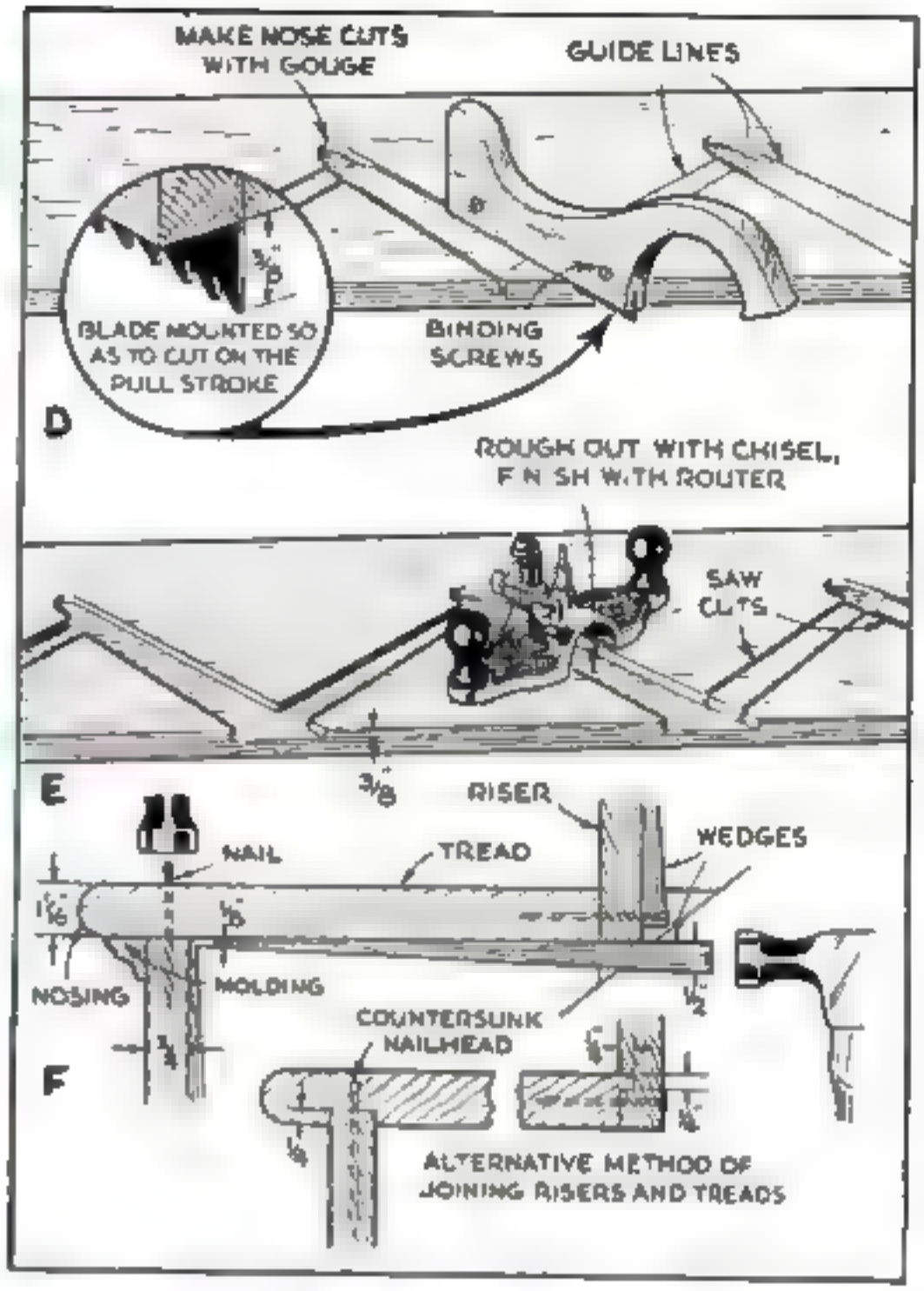
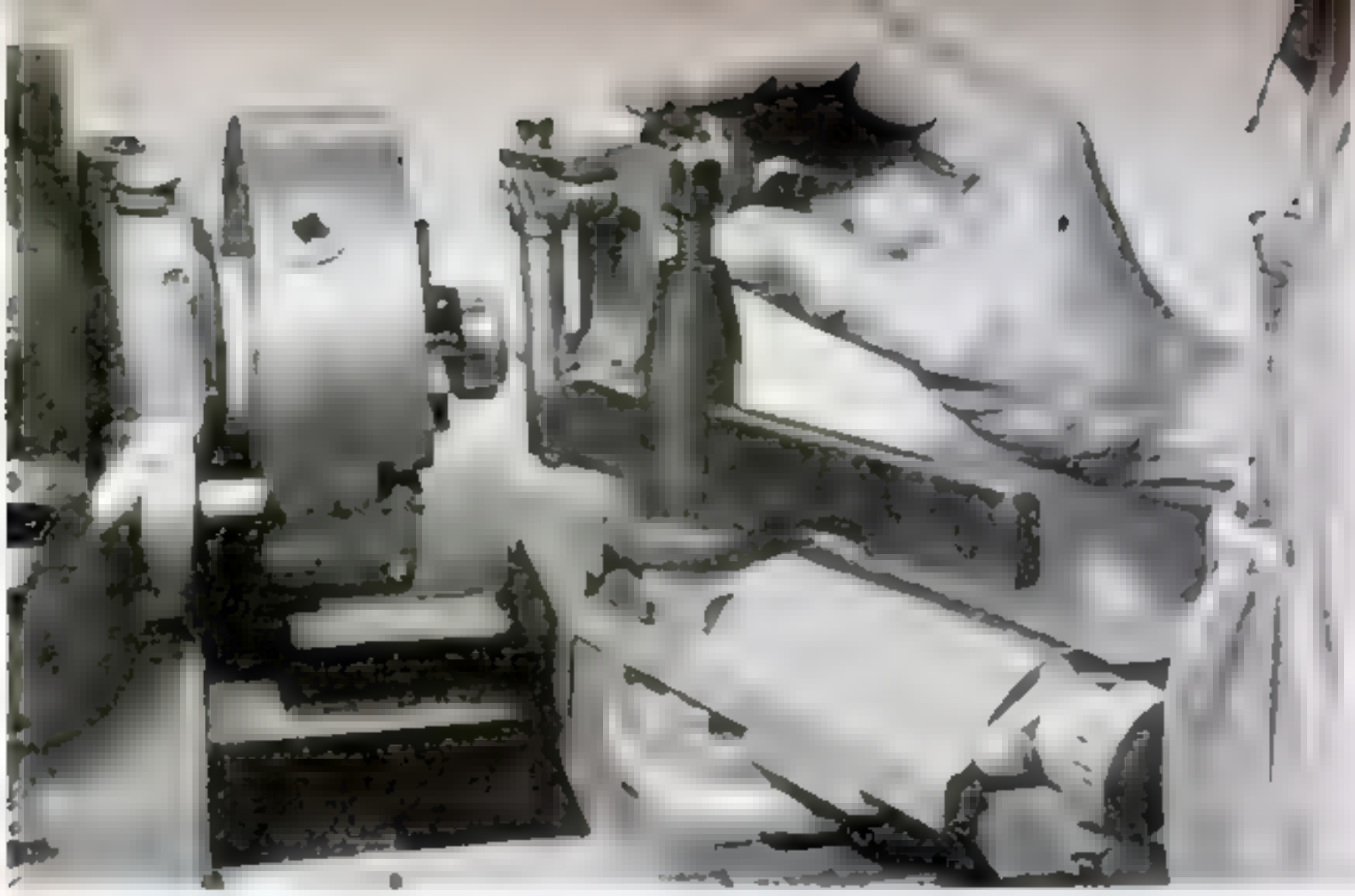


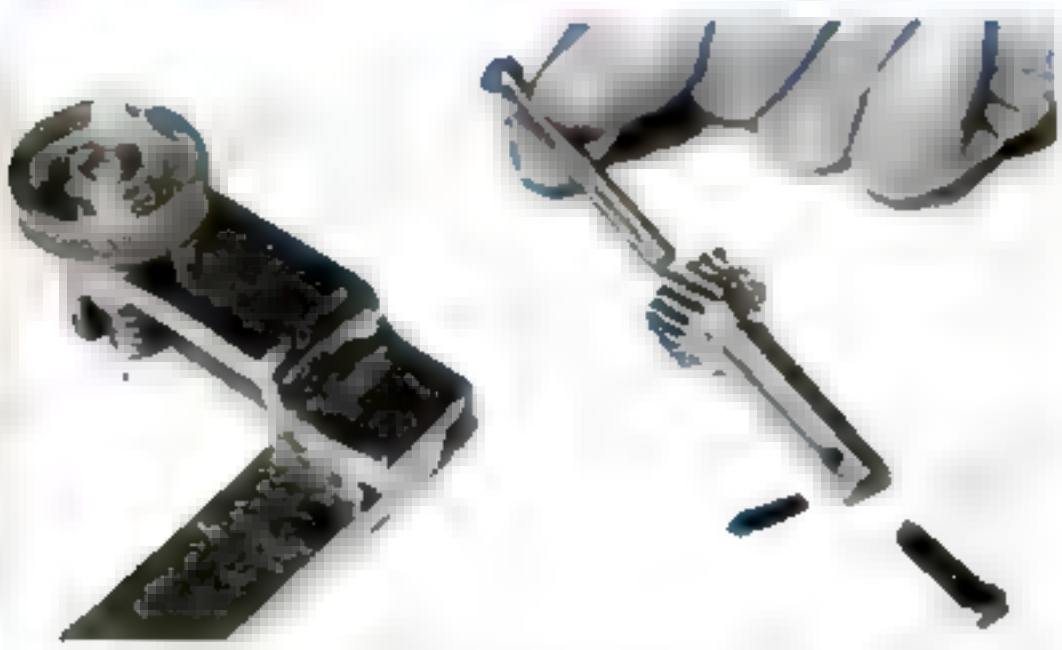
Fig. 2



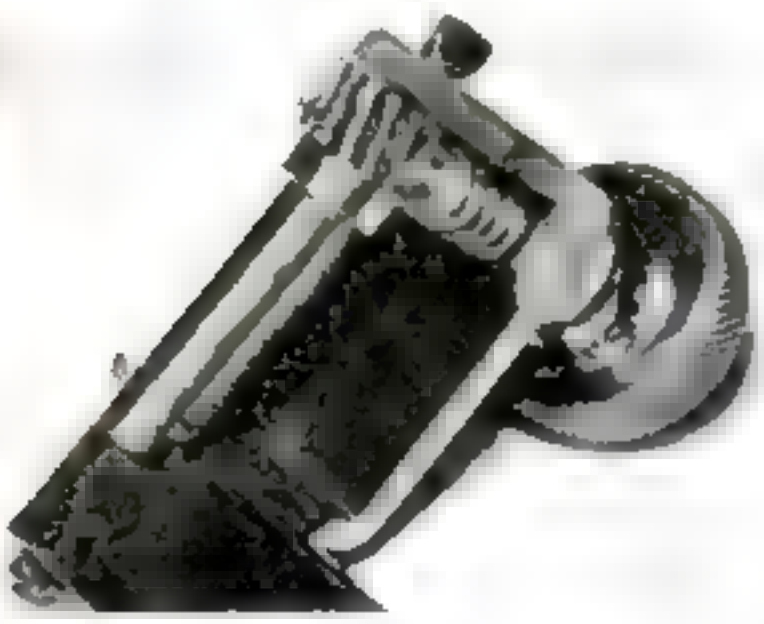
When space permits, it is best to assemble the stairs and install them as a unit. This may be done when one side is open, as with the basement stairway at right. Strength is added by driving nails through the stringers into the treads and risers



Radius-Turning Tool



Parts of the radius-turning tool with the upper stud being inserted in the shaft. The bit it will grip and the lower stud are nearby. Below, the tool assembled



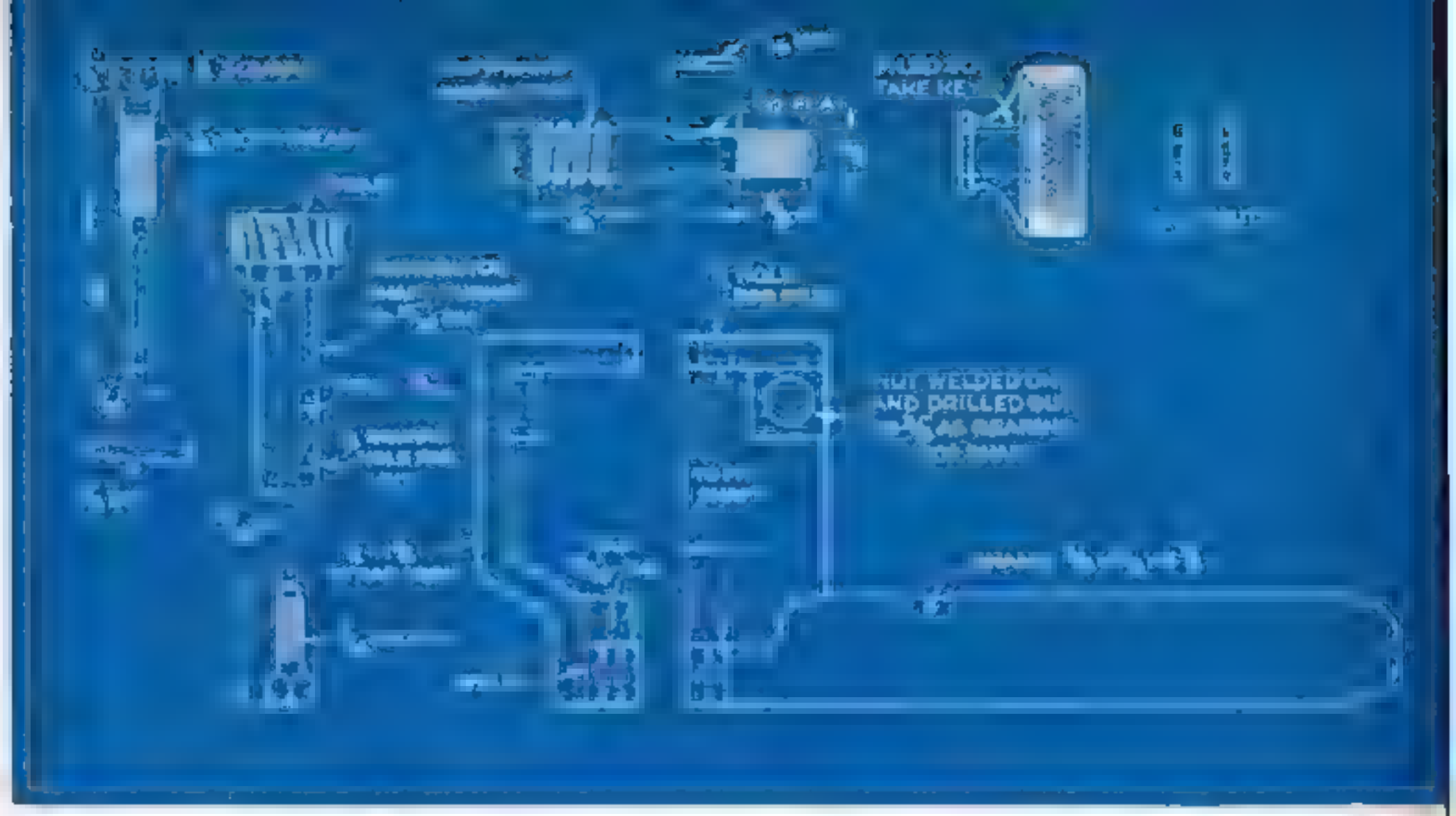
By BENJAMIN NIELSEN

A TOOL that will turn true concave radii of from ⅝" to 1⅝" with mechanical precision can be made from scrap parts on any screw-cutting lathe. For turning smaller radii, the design might be modified by so filing the shaft on one side that the tool edge may be set closer to the pivot.

The vertical shaft and gear were parts of a junked automobile distributor shaft. Select one having a fine-toothed gear. Drill a ⅛" hole through the shaft at a slight angle, as in the drawings, for the tool bit. This hole can be roughly squared with a broach made by grinding a punch square. It is finished with a small square file.

Mount the shaft in the lathe, square the ends, and drill in for 1" from the gear end with a No. 7 drill. Tap this hole ¼"-20. Follow with a 5/32" drill down to the tool-bit hole, and use the same size drill to make a shallow blind hole in the other end of the shaft. Turn the shaft down to 15/32".

Forge the bracket from strap iron, or have a blacksmith make it. The ⅝" by ⅜" shank is forged somewhat thicker on the end. It is welded to the



from Scrap Materials

bracket, and a steel nut is welded fast in the upper bend of the bracket. Drilled out to ⅝", this nut forms a bearing for the worm shaft.

The latter is turned from a piece of steel rod. Cut the worm to the same pitch as the gear; the worm shown is a left-hand one. A knurled knob, once part of a windshield bracket assembly, is locked on the shaft with a flat key and two nuts after the worm gear is in its bearing.

Turn the two studs from steel rod. Drill the two holes in the frame to fit them, making certain that these are accurately aligned and at the right distance from the worm shaft to make the gears mesh properly. Tap the lower hole for the short stud.

GOLD PLATING [ELECTRICAL]

Articles to be gold plated, unless of copper or brass, should first be plated with copper. When the gold plating is to be very thin, the color of the deposit is more easily controlled if the copper-plated work is also plated with silver or nickel before plating with gold.

All electrolytes for gold plating are very poisonous because of their cyanide content. A satisfactory solution for plating with pure (24-carat) gold consists of: gold chloride, ¼ oz., sodium cyanide, 1½ oz., and sodium bisulphite, ½ oz., dissolved in 32 oz. distilled water. It will be necessary to use either a pure gold anode or an insoluble anode such as a hard carbon rod. The latter should be suspended inside a closely woven muslin bag which will retain any particles of carbon that may loosen from the rod. An insoluble anode requires the addition of more gold to the electrolyte to replace that deposited on the work.

For plating with 14-carat gold, a suitable solution consists of: gold chloride, 3 pennyweight; sodium cyanide, 3 oz.; and copper carbonate, 20 grains; dissolved in 32 oz. distilled water. An old 14-carat solid-gold ring will serve for the anode.

Use the electrolyte at a temperature of about 150 deg. F., with a current of from 1 to 2 volts. The current can be controlled by immersing more or less of the anode in the plating solution. With low voltage and a cool solution the deposit is pale; as the temperature rises and the current is increased, the color deepens and becomes richer. However, too much current will give the work a brown appearance which indicates an unstable deposit. The addition of copper-plating solution for copper carbonate will give the deposit a warmer rose-gold tone. A little silver solution will cause a greenish gold to be deposited, while a little nickel cyanide will give the familiar white gold plate.

Remove both solid-gold and insoluble carbon anodes from the electrolyte when they are not actually in use. When the inside of a container or goblet is to be plated, merely fill it with plating solution and suspend the anode in it. If much work is done, save the water used to rinse the work after plating. Gold can be salvaged from it, and also from old electrolytes, by adding sufficient ferrous sulphate to cause complete precipitation. The gold will settle to the bottom as a brown powder.

To strip the gold from old plated articles, suspend them as the anode in a 5-percent solution of sodium cyanide, using a piece of iron as the cathode. The passage of current will cause the old gold plating to be dissolved, and it can later be recovered by precipitation with ferrous sulphate.

POPULAR SCIENCE MONTHLY SHOP DATA

Massive Door Bolt Made from Pipe and Rod

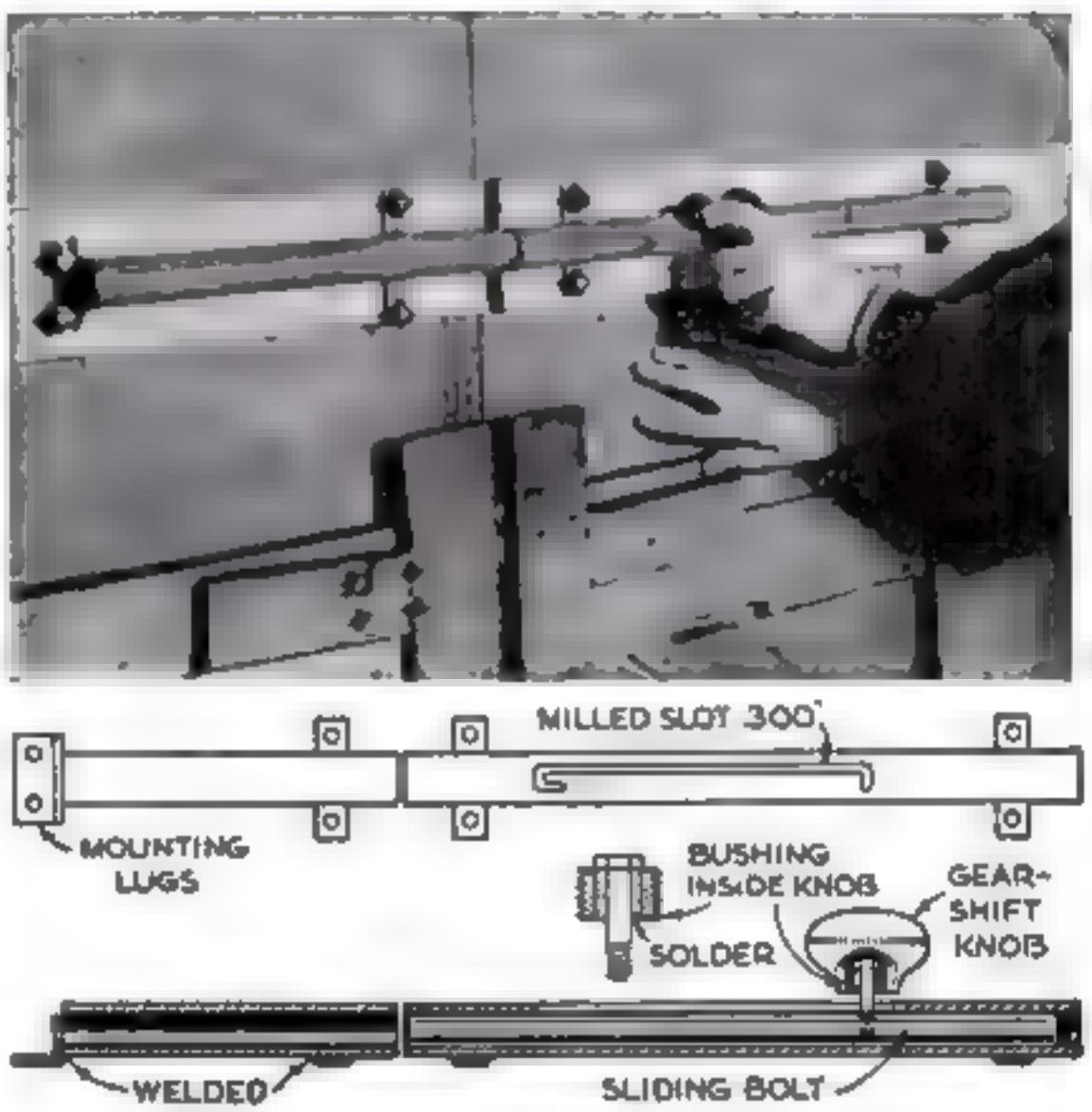
ASSEMBLED almost entirely from scrap materials, this giant barrel bolt can be used for fastening large doors of garages, shops, warehouses, and factories. The model shown has a barrel made of 1" pipe, but only a few dimensions are indicated on the drawings because the bolt can be as massive as required.

Materials include two pieces of pipe, one twice as long as the other, for the barrels; a third pipe or solid rod as long as the longer barrel section and of a diameter that permits it to slide easily inside the barrel; four mounting lugs, one a piece of angle iron and the others strips of bar iron ¼" thick or thicker; a ¼" bolt to which is attached an old automobile gearshift knob or similar handle; and mounting bolts or screws.

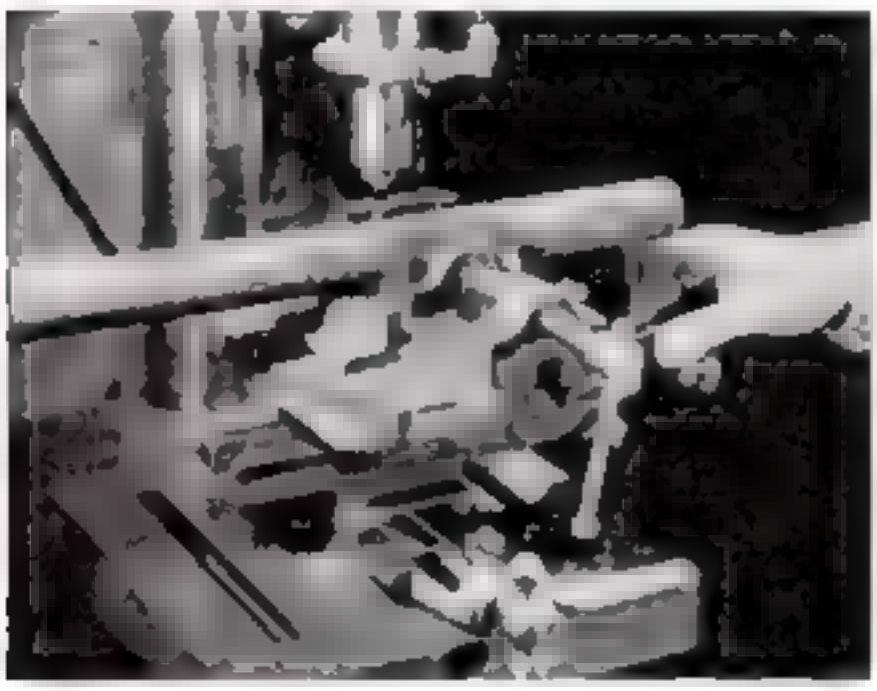
In the longer barrel section mill a slot .300" wide and not quite as long as the shorter barrel section. Shape the slot as shown, with the turned-back portion downward. Cut the mounting lugs to shape, drill them for bolts or screws, and weld them to the pipe. With the bolt inside the longer barrel section, punch-mark it for the ¼" handle bolt. Remove, drill, and tap. If pipe is used for the sliding bolt, the handle bolt should be run tightly against the opposite side.

Finish the outside surfaces with enamel. The sliding bolt and edges of the milled slot can be lubricated with a grease of the type used on automobile door latches.

The barrel slot can be cut by hand if necessary. Make it about 5/16" wide and at one end of the barrel, instead of as shown, cutting all the way through both sides with hack saw, drill, and file. The unwanted slot on the back can then be brazed shut or left open. If welding facilities are not available, the barrel can be mounted with heavy pipe straps or U-shaped pieces of bar iron.



Used on large double doors, a barrel bolt of this type holds securely. The barrel is made from pipe of any size required

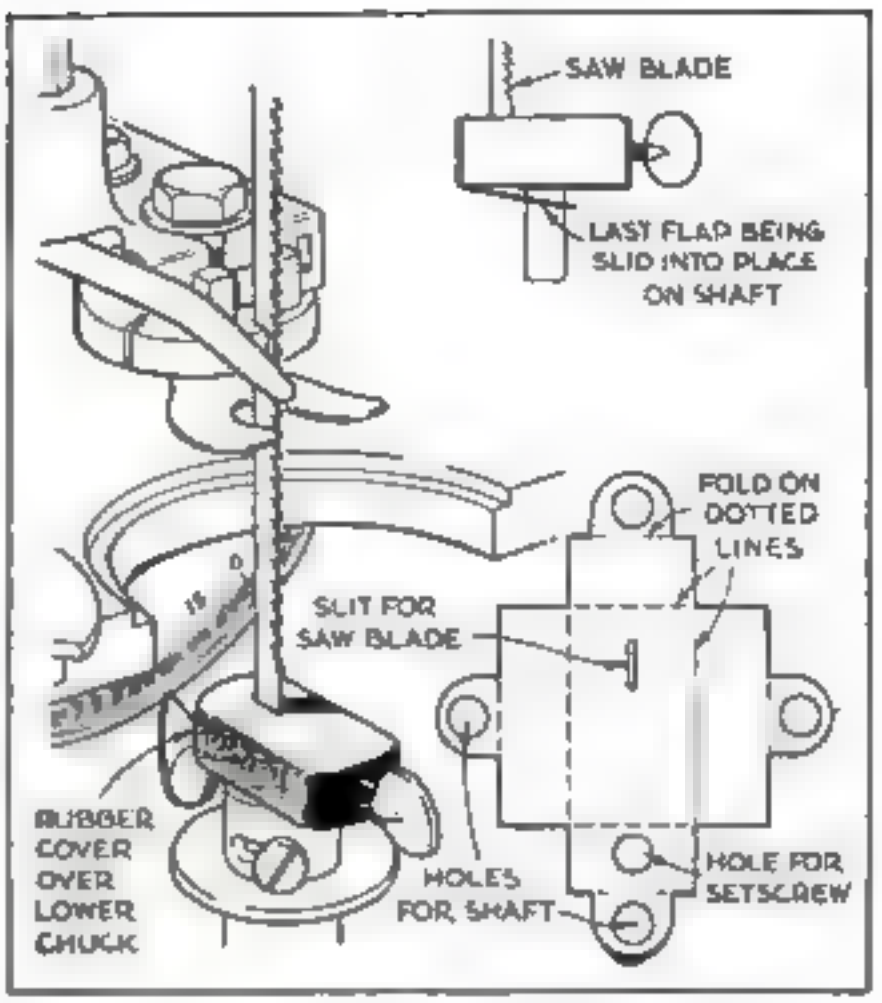


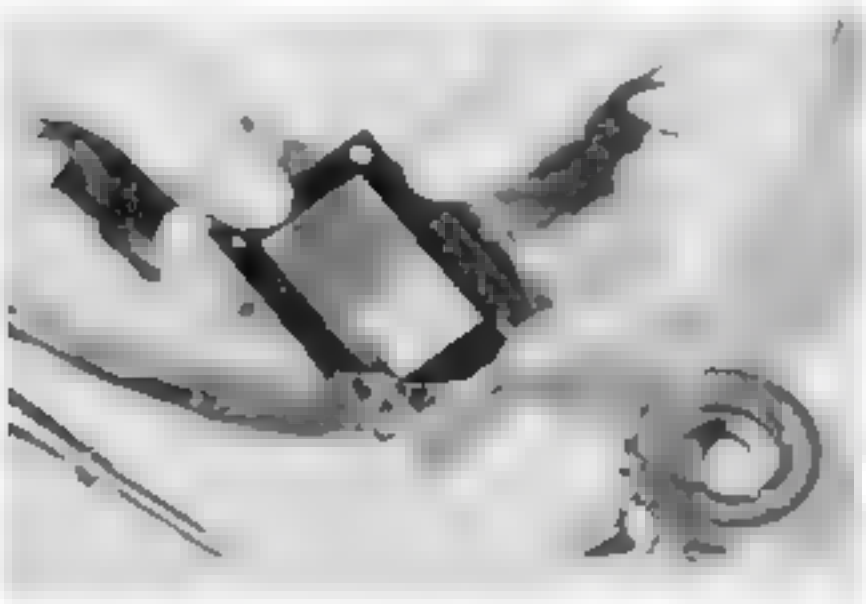
In one section of the barrel, a slot is cut for the bolt handle. Here the slot is being milled

For the handle, an old gearshift knob is fastened to a short bolt and screwed into the sliding bolt

Rubber Cover Keeps Sawdust Out of Scroll-Saw Chuck

WHEN the lower chuck of a scroll saw becomes clogged with sawdust, there is danger of stripping the threads or even breaking the parts. This may be avoided by using a tight-fitting chuck cover, made as shown from old inner-tube rubber and slightly smaller than the chuck. To install, detach the chuck, remove the saw blade, place the cover over the chuck, and fold the flaps down. Then insert the chuck shaft through the hole in each flap. Pass the setscrew through the small hole in one of the side flaps. Replace the chuck on the machine and insert the saw blade through the slot in the top of the cover. If closely fitted, the cover will not interfere in any way with the working of the saw. It is not necessary to remove the cover from the chuck when replacing blades.—R. M. WOODBURY.





Tape Holds Nut in Alignment While Bolt Is Started

ATTACHING a bolt and nut in a tight, scarcely accessible spot, where the fingers can't be used to get a hold, is a difficult task. It can be made easier merely by fastening the nut over the bolt hole with a piece of cellulose or adhesive tape. This will hold the nut in place while the bolt is inserted and turned home. Either a nut or a lock washer, or both at one time, can be held in this manner.—KENNETH MURRAY.

HOW TO CUT SAFETY GLASS [SHOP METHODS]

Steps in cutting safety glass like that used on automobiles are as follows

1. Score the glass along one surface in the usual way with a glass cutter.

2. Lay the glass on a table with the scored line on top and directly above the table edge.

3. Place one hand on each side of the scored line and press down on the overhanging part until you see or hear the glass crack along the cut. Or you can secure one section with a board and two C-clamps, and press on the overhanging portion with both hands.

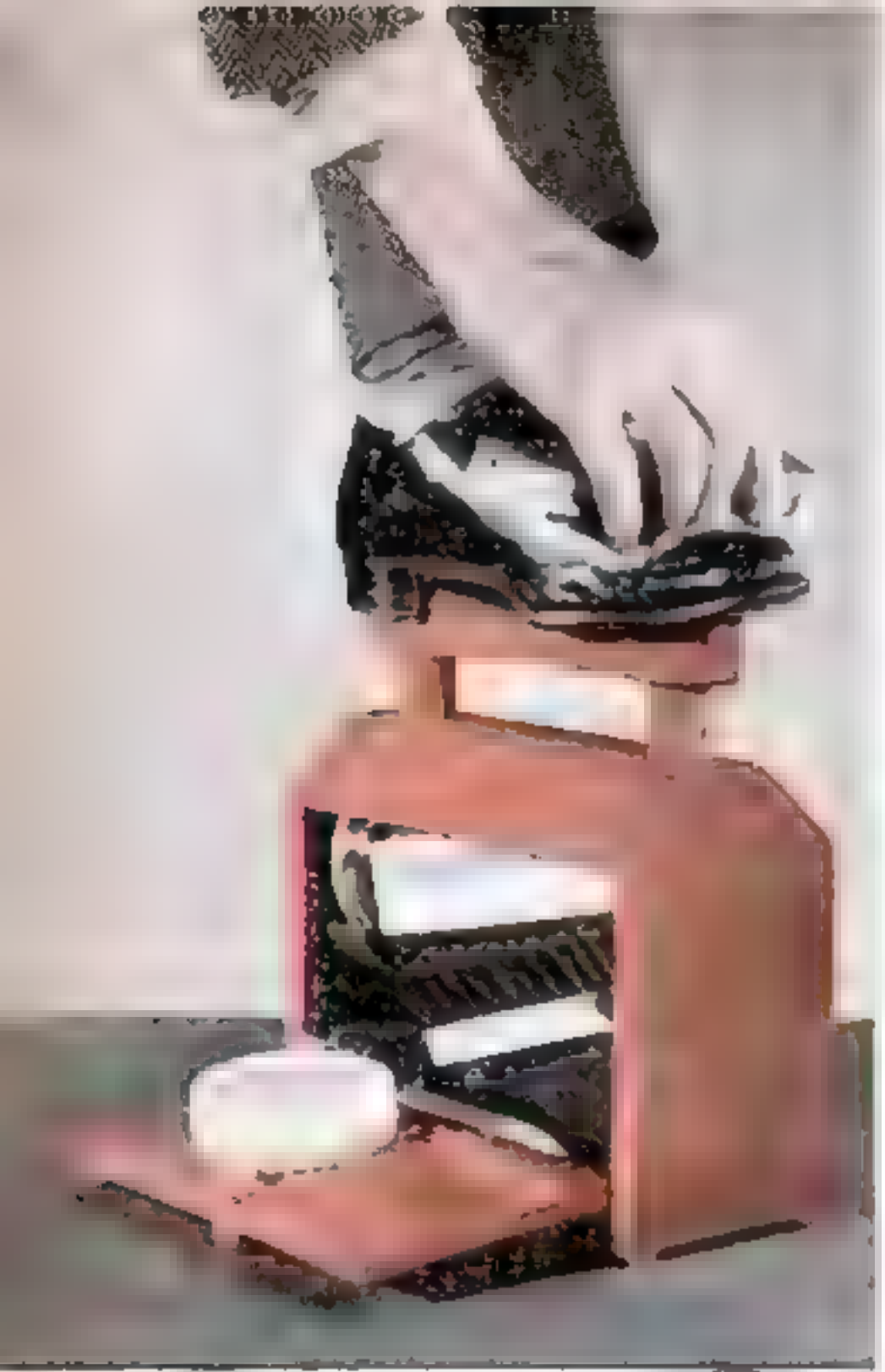
4. Turn the glass over and score a second line exactly opposite the first.

5 Repeat steps 2 and 3 to break the layer of glass on the second side.

6. Work the glass back and forth to break the plastic sheet at the center. If it doesn't part readily lay the glass over a small stick or rod, weight down the two sections to spread the cut, and separate the plastic sheet with a thin razor blade.

To cut "chicken-wire" glass, simply score one surface, and break in the usual way The embedded wire snaps off readily.

POPULAR SCIENCE MONTHLY SHOP DATA



Compact

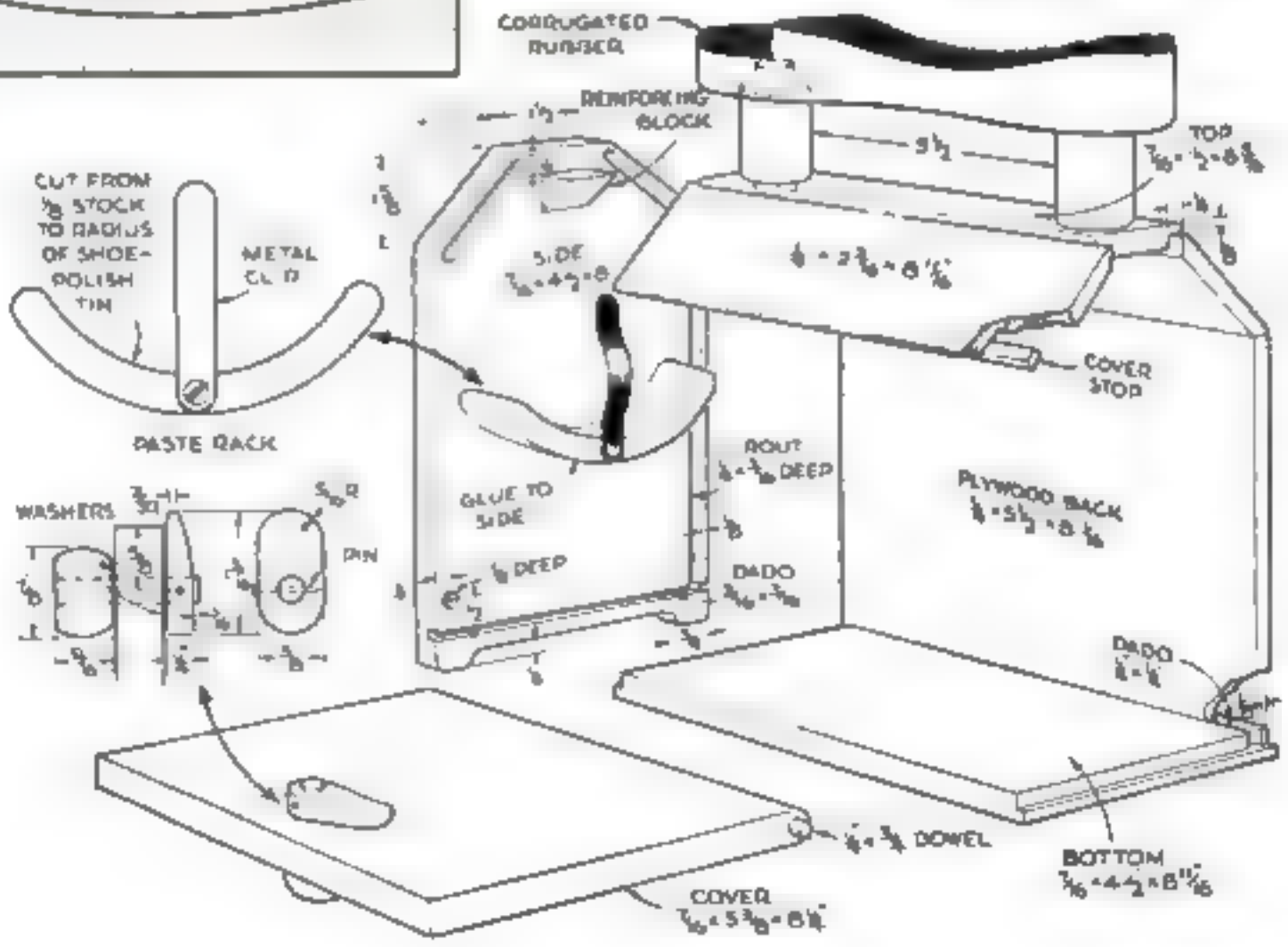
Designed by ERNEST R. DEWALT

INSTEAD of keeping shoe-shine supplies in a crowded closet or under the kitchen sink, and perching each foot on the corner of a chair for the morning brush-up, why not build this combination kit and stand? It will hold two sets of brushes, daubers, polishers, paste, and polishing cloths, and keep them together within arm's reach while you are shining your shoes. The footrest attachment will help keep the chairs clean, and is a lot more convenient.

The two sidepieces are dadoed for the bottom, the back, and the sloping toppieces. On each is mounted a band-sawed piece having a spring clip attached to hold shoe-polish tins securely. Drill a ¼" hole ¼" deep in each sidepiece for the door pins. Note that there is no dado for the flat toppiece, which is simply glued to the other two and reinforced with two corner blocks.

This piece and the two sloping ones are easily cut on a circular saw. A cleat of the same length is fastened to one of the ¼" pieces as a stop for the door, and a shallow groove is cut at its center for the latch. Cut the door to size and glue in two ¼" dowels, ⅜" long, as hinge pins.

Glue the case together with the door in place. While the glue sets, saw the footrest to shape from 1⅛" stock. Turn shoulders on two pieces of 1" dowel, screw these fast to the top of the box, and glue the footrest



There is ample space in the box part of this shoe-shine kit and stand for all equipment needed. Build the box first, assemble as a unit with glue, and then saw out the footrest while the glue sets

HW 164

Shoe-Polishing Kit

to them. There should be enough clearance under it so that it may serve as a handle.

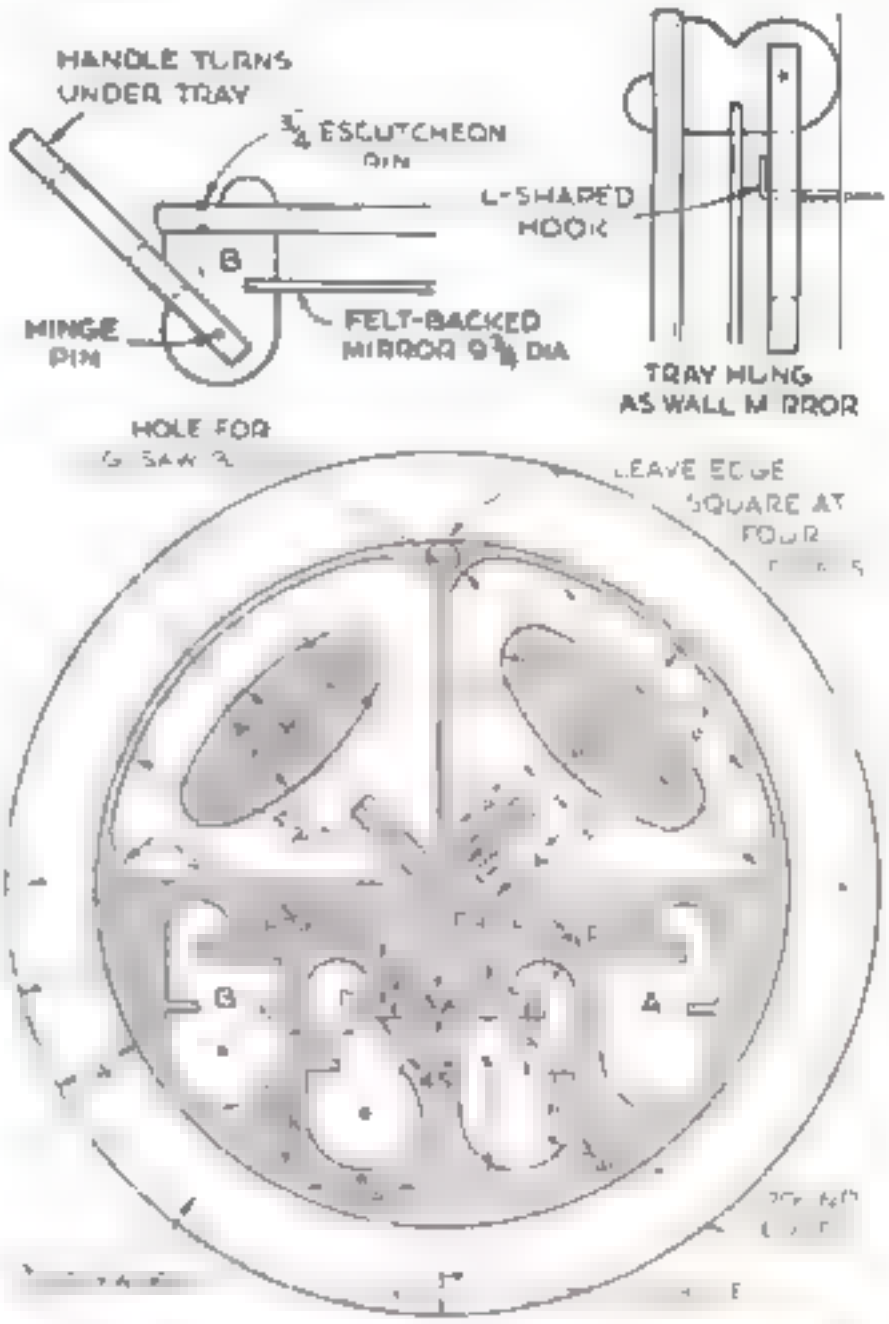
The latch knob should be marked with a line or an arrow to show when the catch is engaged. Round off all outside edges slightly and sandpaper the piece all over. Apply a filler coat of thinned floor varnish. Follow with two coats of enamel. Cement corrugated rubber from an old doormat to the top of the footrest. Approximate time, 5 hours.

Decorative Fruit Tray Serves Also as Modern Wall Mirror

A MAXIMUM of utility is gained from a minimum of material in this attractive, out-of-the-ordinary mirror-bottom fruit tray. With the handles turned under, it may be hung as a modern wall mirror. Only a 12¾" disk of ⅜" plywood, a felt-backed mirror 9¾" in diameter, and a few escutcheon pins are needed. The dimensions can be altered for a different size glass.

Jigsaw the ring to size and round the inner and outer edges on a shaper or by hand. At four points where the legs go, ½" of the inner edge is left square. Four legs and two handles are cut out of the waste from the center. Note that two legs are notched on the outer edge so that the handles, pivoted on finishing nails, turn up for carrying. With all legs on one side of the ring, insert the mirror; then slide the legs around to their proper places. A touch of glue and an escutcheon pin secure each.

A modern finish may be obtained by rubbing in light blue paint thinned with a little oil and turpentine. Wipe off the excess and, when dry, wax and polish the piece. Approximate time, 4 hours.



Walnut Wastepaper

By J. I. SOWERS

WORTHY of the best efforts of any craftsman, this wastepaper receptacle can be built to do double duty in an emergency as a small coffee or end table. The top shown in the small photograph is mortised to fit firmly on the top of the posts and can be lifted off entirely when it is desired to use the piece for its original purpose.

Walnut stock was used for the piece illustrated. The carved panels represent a conventionalized design of holly. If some other design is preferred, it should be kept in mind that the work is to be seen from a distance and from above, so the carving should be bold and deep. A good book on wood carving would be a great help to the novice.

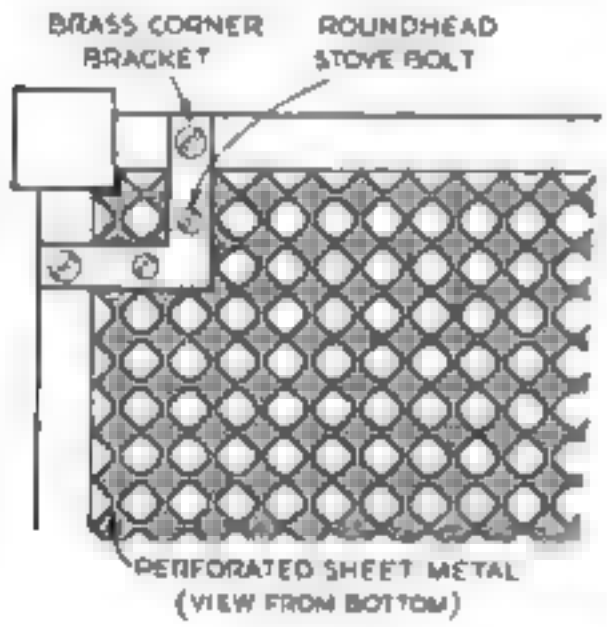
All joints are made with mortises and tenons, as the drawings show. It will be noted that extra stock must be glued to the bottom and top of the leg pieces; that is, these are post-blocked to avoid the necessity of turning and planing down heavier stock for the smaller dimensions between them.

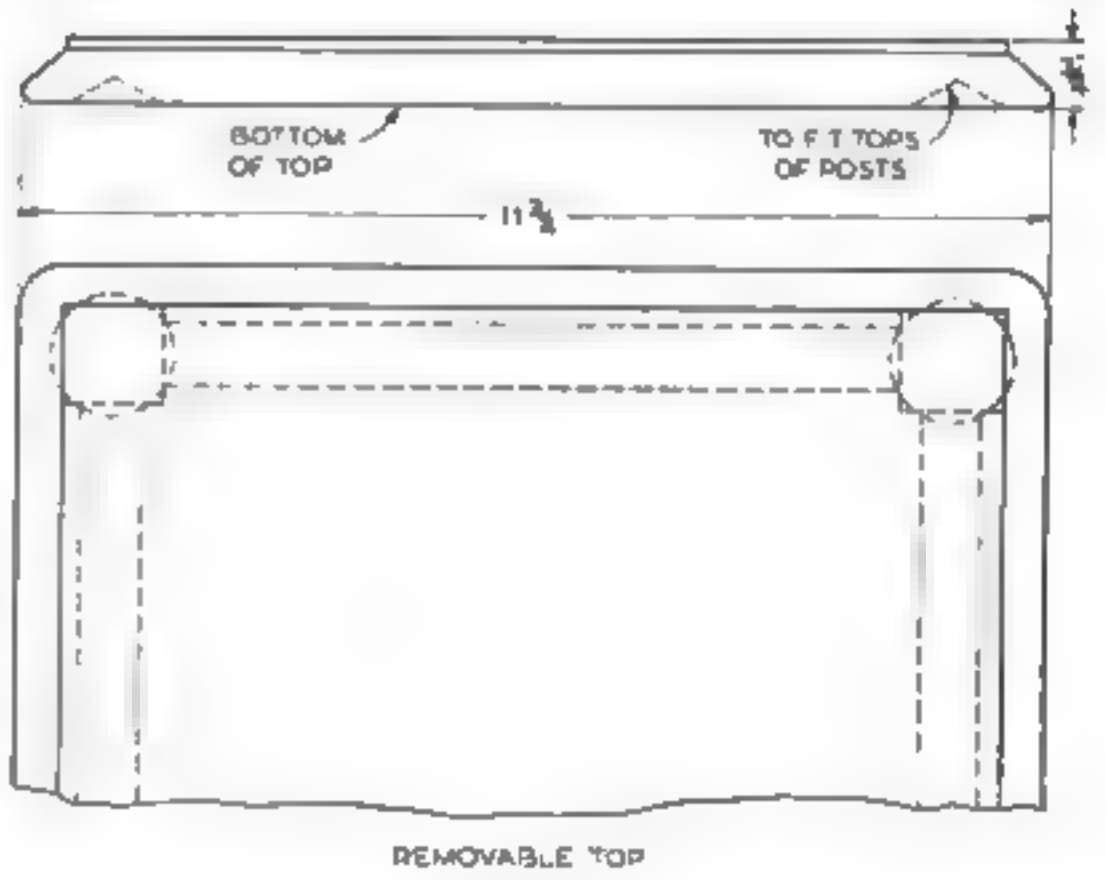
The bottom is cut from perforated metal, obtainable in stock patterns for grilles, radiator inclosures, and the like. This sheet metal is cut to a size about 1/16" smaller on all sides than the bottom opening, notched around the posts, and held in place by brass corner brackets. If perforated metal is not available, strips of any suitable material may be substituted, but do not use a solid bottom, as it is harder to keep clean.

The edges of all rails should be neatly rounded. This tends to prevent the unsightly accumulation of dust. Round off and smooth the inside edge of the handles.

An oil and rubbed-wax finish was used on the piece illustrated to bring out the natural beauty of the grain.

For the bottom, cut perforated metal slightly smaller than the opening, notch the corners, and attach with four angle brackets



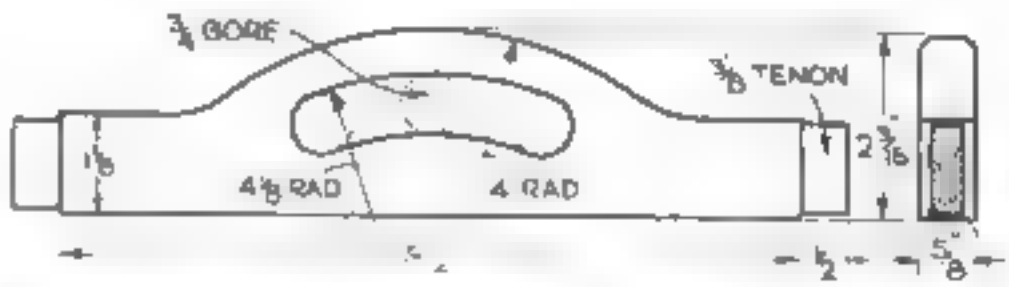


LIST OF MATERIALS

No. Pc	Description	T	W	L.
4	Legs	1½	1¾	16
8	Rails	⅞	1¾	9½
2	Rails	⅞	1¾	11½
2	Handles	⅞	2 3/16	9½
4	Panels	¾	5¼	9
16	Stays	¼	1¾	3
1	Top	¾	11¾	11¾
1	Bottom	¼	8¾	8¾

Miscellaneous: 4 small brass brackets, 8 flathead brass wood screws, 4 roundhead brass bolts and nuts

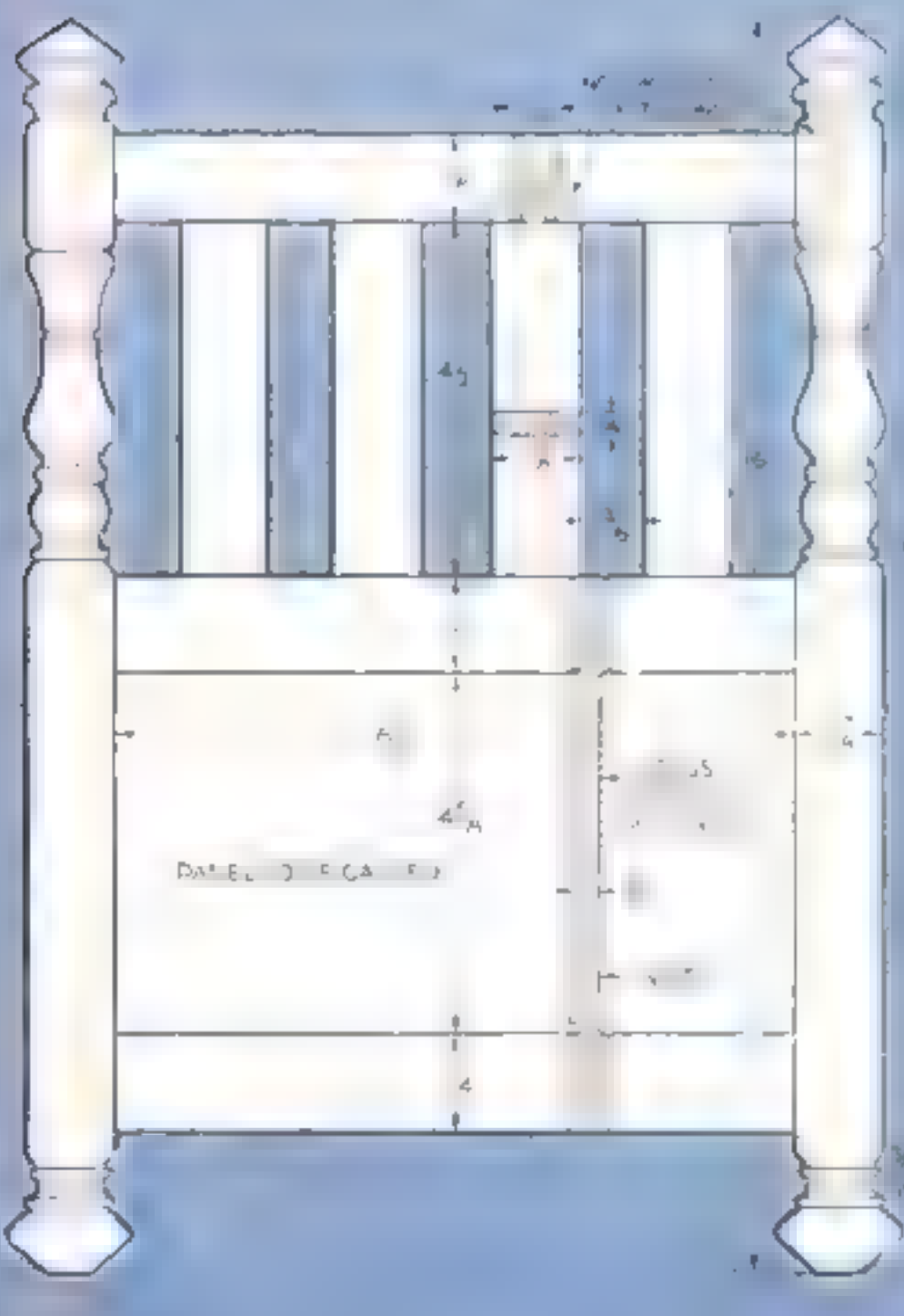
Note: All dimensions are given in inches and are finished sizes.



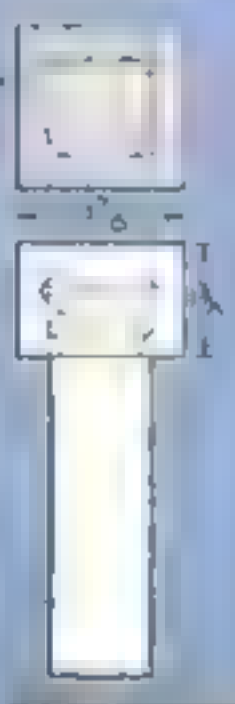
At top and center, two views of the removable table board, which may be made from one piece or two narrow ones. A handle rail and corner-post joint are shown at bottom

Container

This piece of beautifully grained wood is ordinarily a receptacle for wastepaper but add the removable top shown above, and it doubles as a convenient coffee or end table



In the drawings at left are shown in detail the construction of sides, panels, slots, and post turnings, and method of post-blocking the ends



Conventionalized holly is the panel design shown below. Another may be chosen, but in any event lay it out on paper first and be sure to carve boldly

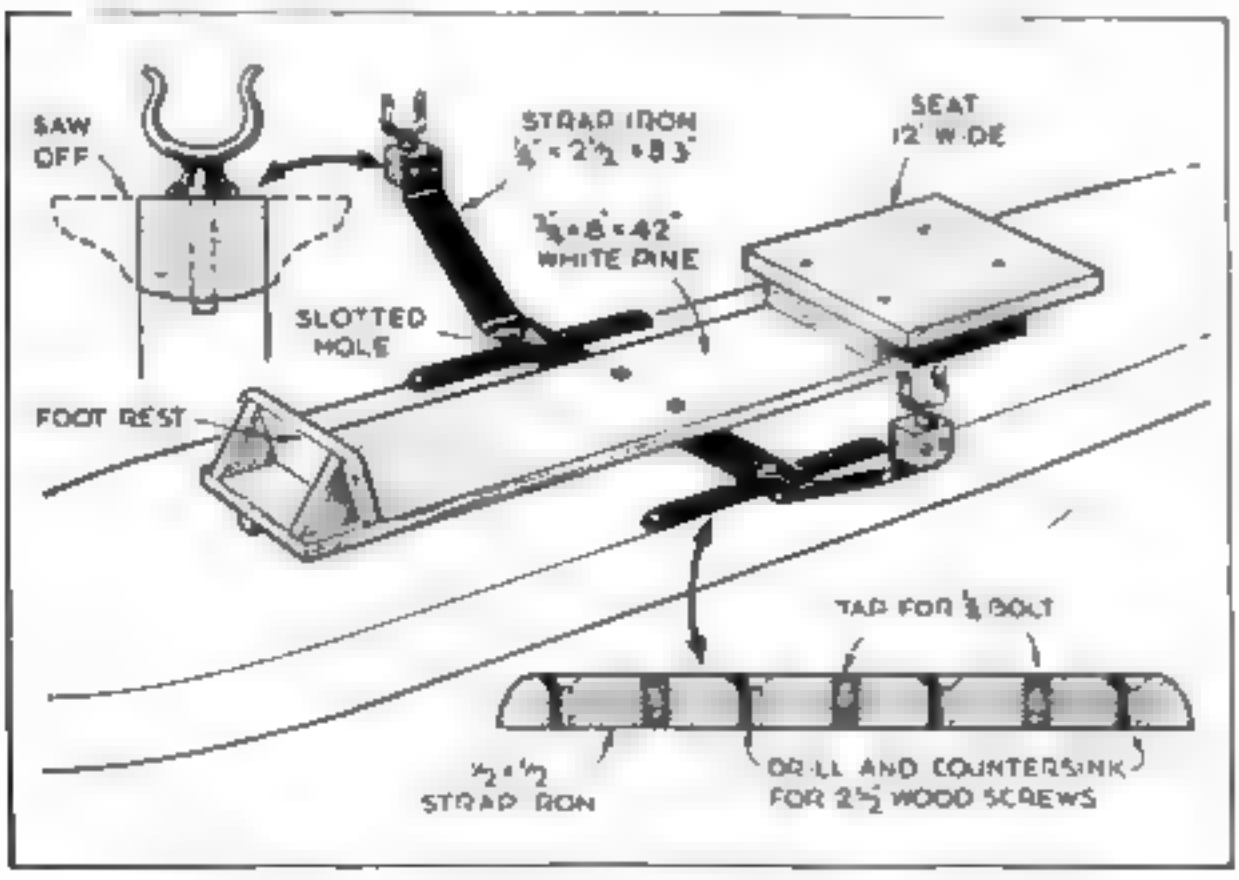
DETACHABLE

Rowing Rig

TURNS SURFBOARD INTO RACING BOAT

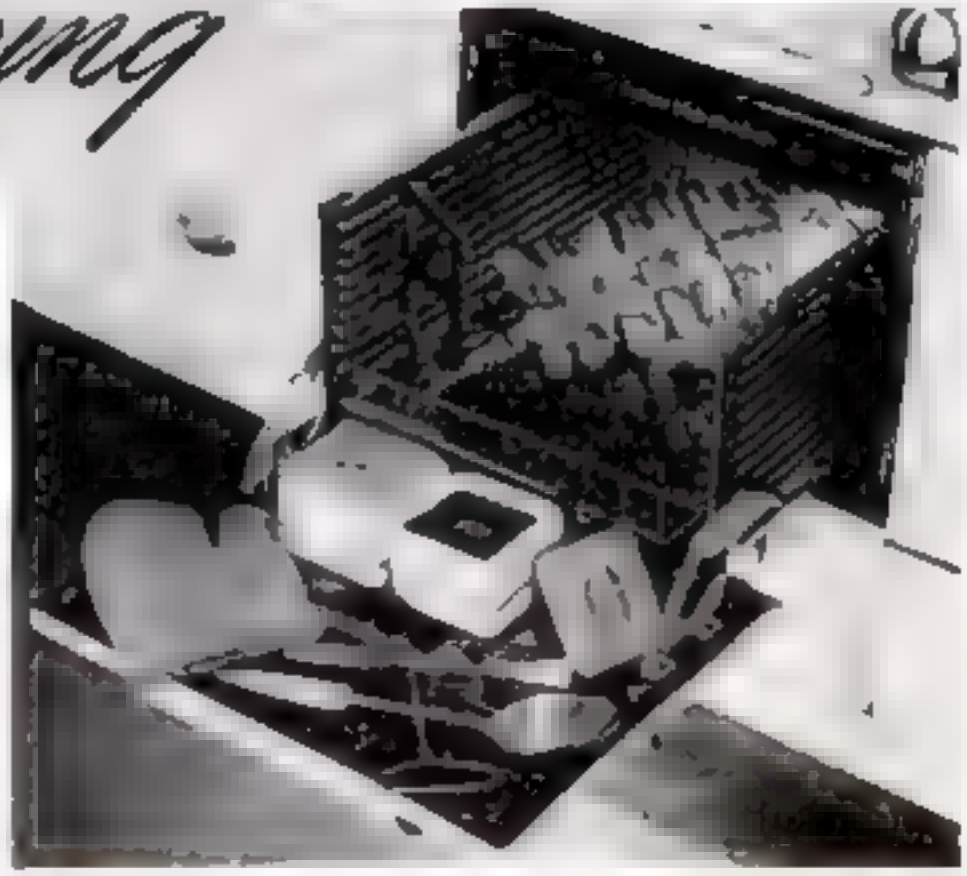
A SURFBOARD can be converted into a speedy one-man racing "shell" by the addition of a detachable rowing rig consisting of a seat, foot rest, and oarlocks. The seat, which is 12" wide, and the foot rest are fastened to opposite ends of a 42" length of ¾" by 8" white pine, as illustrated in the drawing. A piece of ¼" by 2½" strap iron, 53" long, is bent in the vise for the outrigger as shown, and oarlocks from an old rowboat are sawed off to 2½" to conform to the width of the strap iron and bolted on at the ends. Make two 17/64" wide slots in the horizontal part of the outrigger so that each will be centered just inside one edge of the surfboard. The seat unit and outrigger are then ready to be bolted together.

Next take two pieces of ⅛" by ⅛" iron and drill and tap each at three equidistant points to receive a short bolt, ¼" in diameter. Drill holes for screws between these tapped holes and at both ends, and use eight 2½" wood screws to fasten these strips permanently to the surfboard. The tapped holes will provide three positions for the rowing rig. This can then be attached firmly with only two bolts, which are easy to remove when desired.—JAMES SIMKO.

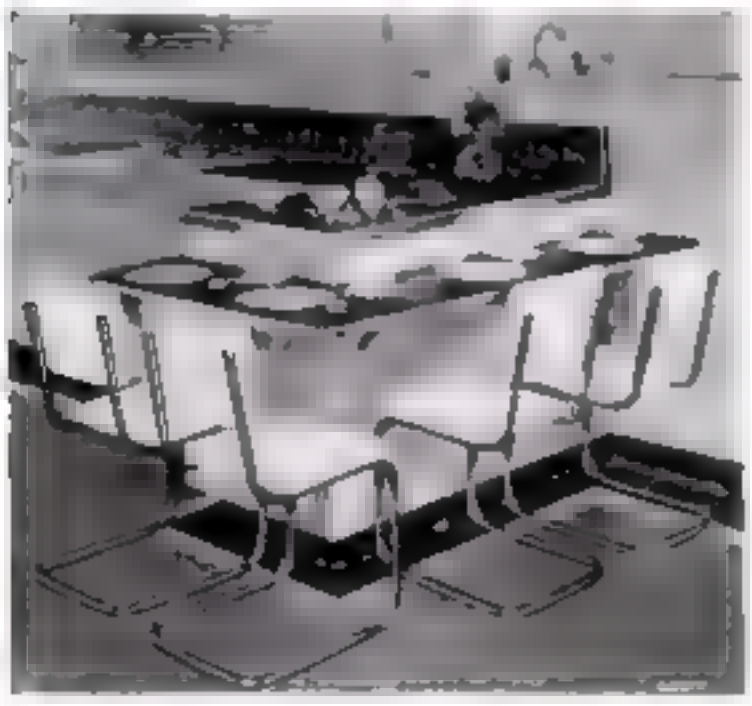


This racing seat is simply made. The supports at the edges, though permanently attached, do not spoil the board for its original use

NEW APPLIANCES to aid in *Housekeeping*



BARBECUING IN THE BROILER is both smart and easy with this new range which has a built-in skewer rack and a skewer long enough for two small chickens or one large piece of meat. The skewer turns freely on a swinging support, holding the meat just below a special broiler burner. Enhancing the atmosphere of a barbecue is a kit containing two pottery sauce dishes in a wire basket, a basting spoon, large fork, pastry brush, and gay asbestos mitt



A MODERN BREAKFAST BAR now may be obtained for attachment to a kitchen cabinet, either old or new, as shown at the left. The installation takes hardly any time, and will add a convenient, cozy eating nook even when there is little room to spare. The material of the cabinet should be of sufficient strength to bear the extra weight, the frame supports sturdy enough to hold alignment, and the arrangement such that either a right- or left-hand grouping of seats can be arranged. When not in use as a dining unit, the counter provides additional work surface within easy reach of sink and cupboards. The bar comes covered with hard fiber board or linoleum, is 14" wide, and may be had by the lineal foot

Tin-Plate Craftwork

WHAT patience and ingenuity will accomplish with tin plate salvaged from cans is demonstrated in a striking way by the projects shown on these pages—projects that won prizes in a recent contest conducted by POPULAR SCIENCE MONTHLY. They bear concrete testimony to the originality of home craftsmen in creating objects of utility and beauty from commonplace materials.

The picturesque post lantern illustrated in Fig. 1, for example, was made entirely from tin cans and tin-can stock by Dr. W. C. Ballard, of Denville, N. J. Beverage and fruit-juice cans of two sizes were used for the post, which is 66" high and reinforced with a wooden core. Each can is soldered to the adjoining ones, making a perfectly rigid structure. Two folded strips were used for the bracket members, which therefore consist of four thicknesses of stock. The silhouette name plate is cut from the side of a large can.

A 5-gal. oil can, paint-can lids, and parts of small cans furnished material for the lantern. This is 18½" high and 9" square at its widest part The cap is hinged and may be opened when it is necessary to replace the bulb. Some of the construction details are shown in the drawing below

Exquisite craftsmanship is evidenced in the glass-inclosed wall lantern shown in Fig. 2. This was designed and built by R. Nino, of Eagle Pass, Texas. The glass panes were set into individual frames formed of U-shaped strips of tin plate, and the frames were then soldered together. The two middle windows form a door that may be opened for access to the candle within. Tin plate from a

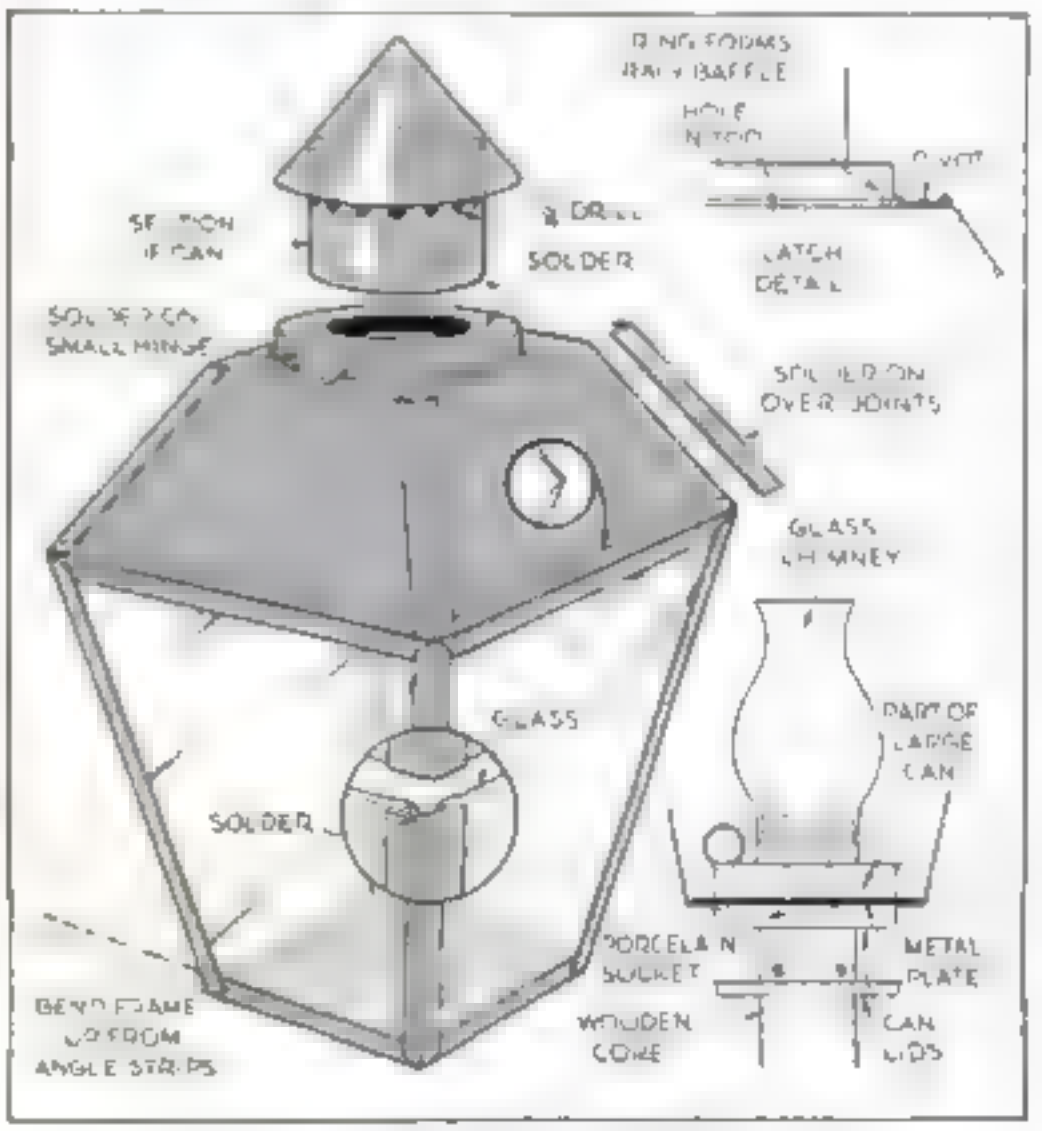


Fig. 1. This is what became of tin cans that fell into the capable hands of Dr W. C. Ballard, Denville, N. J. Two sizes of cans were used for the post. Others provided the material for the silhouette name plate, the bracket, and the lantern details of which are shown at the right

large candy container, glass, and two pieces of iron wire for the hinge and the catch were the only materials used in making this piece. Those who wish to duplicate it will find several helpful hints and a pattern for the back in the drawings.

Another attractive candle lantern (the left-hand photo in Fig. 3) was submitted by James A. Carl, of Tucson, Ariz. A small screw-top can forms the body, to the top of which is soldered a cylindrical chimney and cap. The can was cleanly cut back to half its diameter, the two parts were bent out, and the panels thus formed tooled from the back. A ¾" wide strip of tin is folded lengthwise from both edges and bent to form the handle.

There seems no limit to the variety of things you can make from tin-can metal. At first glance this material hardly seems the thing to fashion flowers from, but Wilbur Cosa, of Clairton, Pa., has done just that and done it well, as shown at the right in Fig. 3. The blossoms are soldered to twisted tin stems. Fernlike leaves are made by slitting a blank at intervals of ⅛" not quite to the far edge, and then bending the narrow strips so formed alternately to left and right, the uncut edge forming a center rib or backbone. A basket can be made by slitting a medium-sized can down from the top to within 1" of the bottom at ¼" intervals. Bend the strips outward, joining their outer ends with a piece of stiff wire, which can be bent to any shape desired.

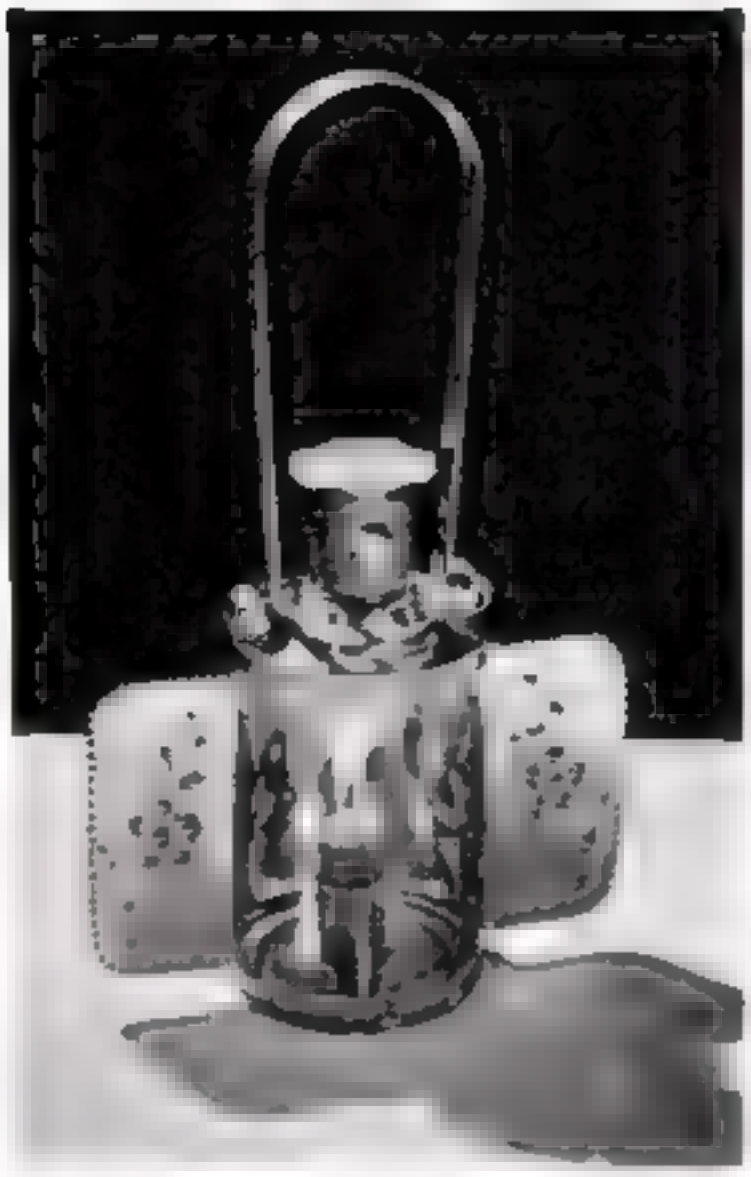
A napkin holder (Fig. 4) made by William J. Catallo, of Elizabeth, N. J., is cut from a single piece of material. Double-thickness strips were bent to shape for the feet and handle, which were attached with tinsmith's rivets. A decalcomania (transfer) provides a touch of color.

All the parts of the HO-gauge hopper car shown in Fig. 5, except the trucks, were made from tin-can stock. So was the ornamental ship model in Fig. 6. The picture frame at the right of it consists of a film-pack case mounted in a sheet-metal holder.

Michael J. Ferro, of Chicago, Ill., made the attractive neckerchief slide shown in Fig. 7 by sweat-soldering two thicknesses of material together, hammering the piece to obtain a textured surface, and cutting and filing it to shape. The Boy Scout emblem also was soldered in place. A U-shaped piece made of a folded strip is soldered to the back

Something different in cake servers has been designed by Frank J. Pizarro, of New York. This is illustrated in the right-hand photo of Fig. 8. The body is a fruit-cake tin, to the bottom of which is soldered a 1½" high section of a 5" coffee can. A ½" plywood ring is cut to fit inside the bottom

Fig. 2. Individual glass lights were set into tin-plate frames by R. Nino, of Eagle Pass, Tex., in making this wall lantern. The open top admits air



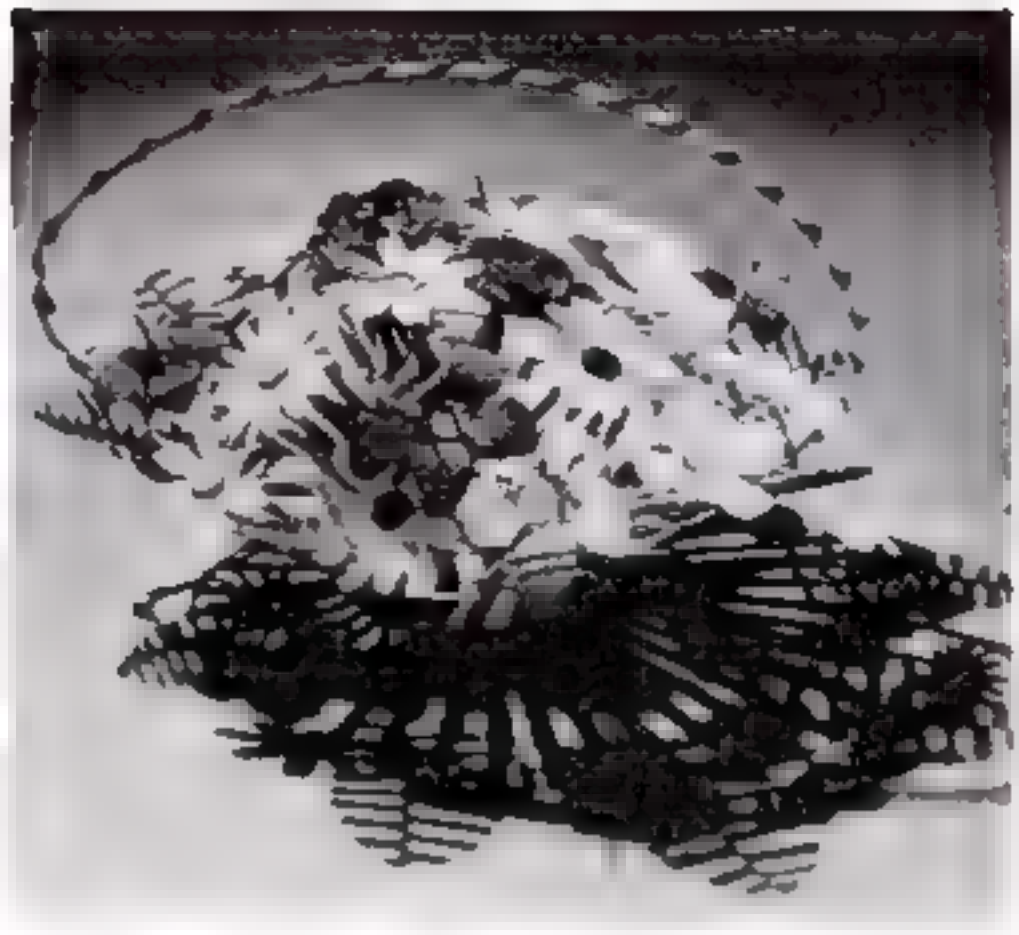


Fig. 3. Left, an unusually attractive candle lantern made by James A. Carl, of Tucson, Ariz. The tooled side panels were formed by bending part of a screw-top can inside out. Above, colorful flowers, ferns, and a basket, all of tin plate, are the handiwork of Wilbur Coss, of Clairton, Pa.

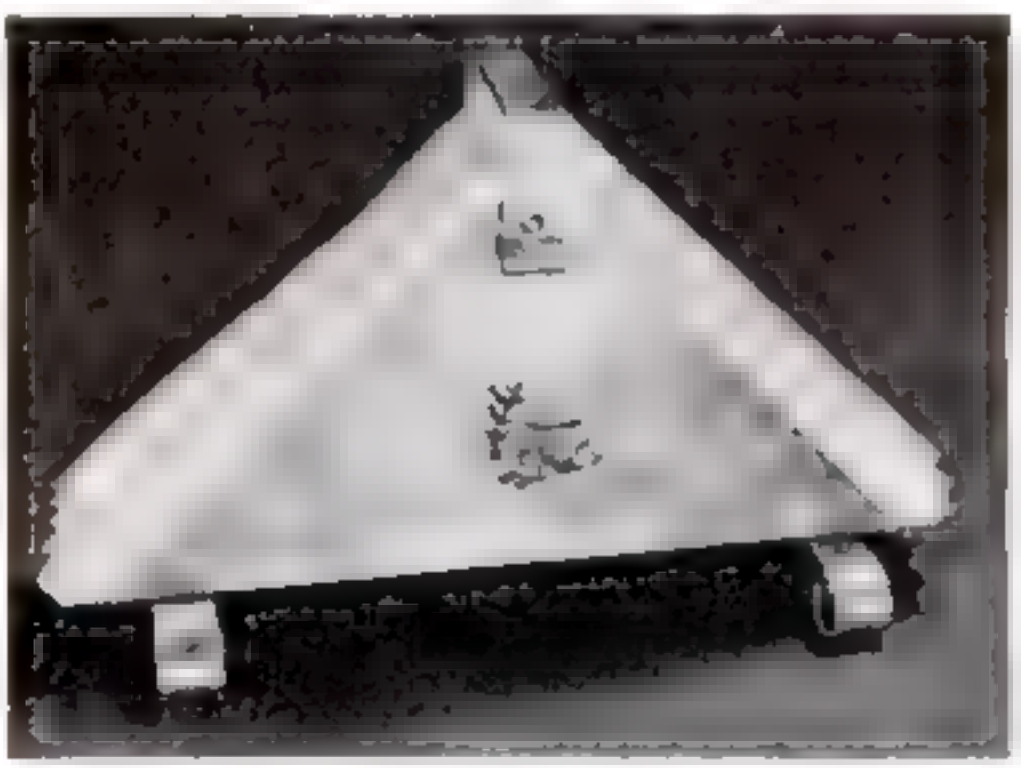


Fig. 4. This napkin holder is 2" wide, 9" long, and stands 6" high. The handle and legs are double-thickness strips

Fig. 5. Ready to roll on any HO-gauge model pike is this realistic hopper car. O. Edward Culver, of Rochester, N. Y., made all parts except the trucks from salvaged tin plate

flange of the cake tin, with a hole large enough so that it may be fitted over the coffee can. The lower edge of this ring is rounded off. The piece is held with wood screws passed through the bottom of the large tin. Two pieces of wood, each ¾" by ⅛" by 7¾", are half-lapped and fastened with screws to the lid. Inverted so that it rests upon these, the cover serves as a cake tray. The entire piece may be enameled or lacquered in any color desired.

Toys are as popular with craftsmen as with the children, and one way to win the esteem of small boys is to build for them such toys as Ralph G. Smith, of Newark, Ohio, makes from tin cans. His steam tractor in the lower photo of Fig. 8 is made entirely from tin-can stock. The steam roller shown in the same illustration is built around a simple plywood frame on which are mounted a tin-can boiler and two rollers made of a coffee can and a small evaporated-milk can. A sturdy tank truck, shown as it looks before being painted, consists of two 2-lb. coffee cans, a cut-away cocoa can for the cab, and an odd-shaped syrup can for the engine hood, all mounted on a simple wooden frame to which are attached six wheels—the cut-out

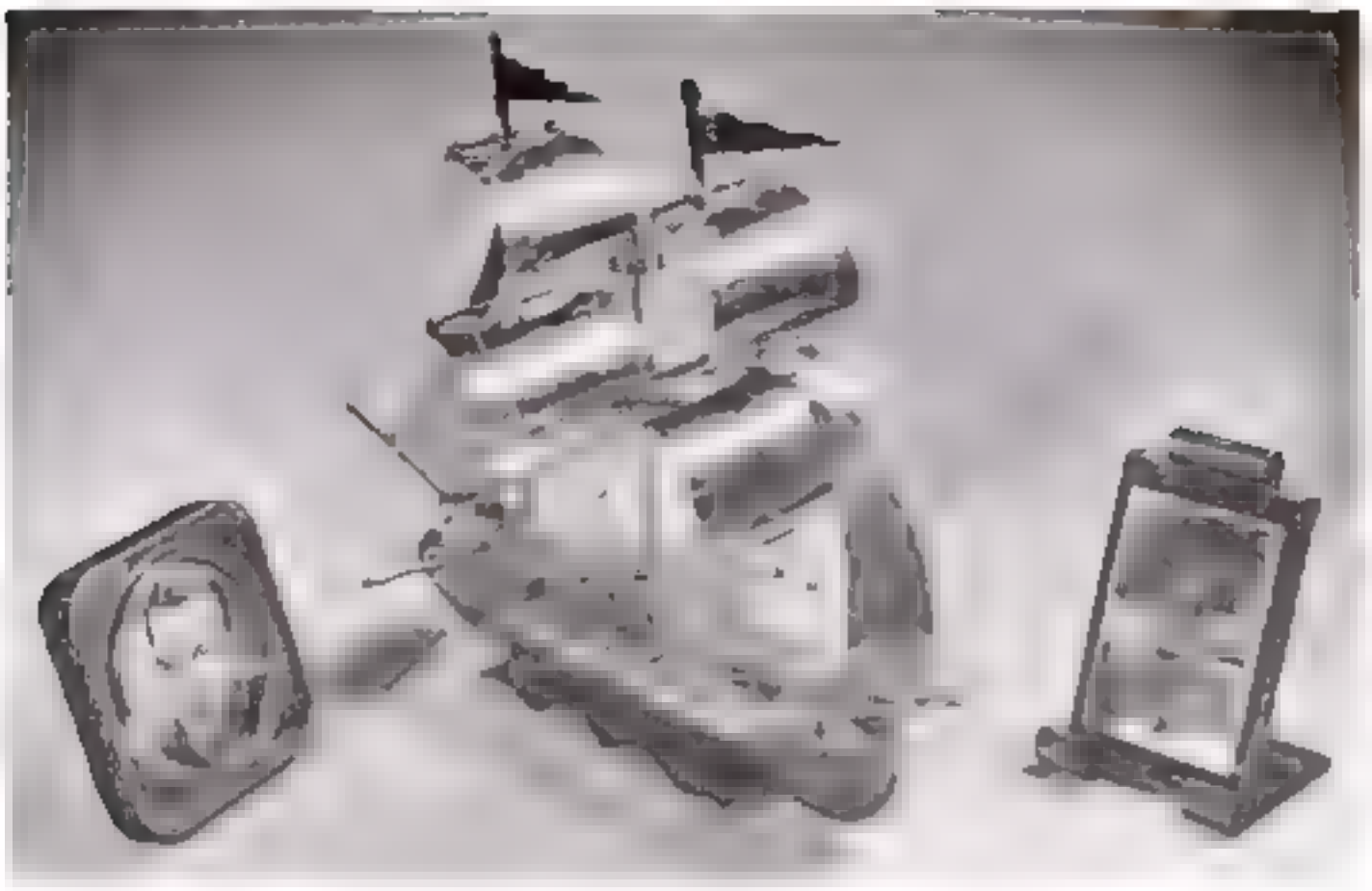


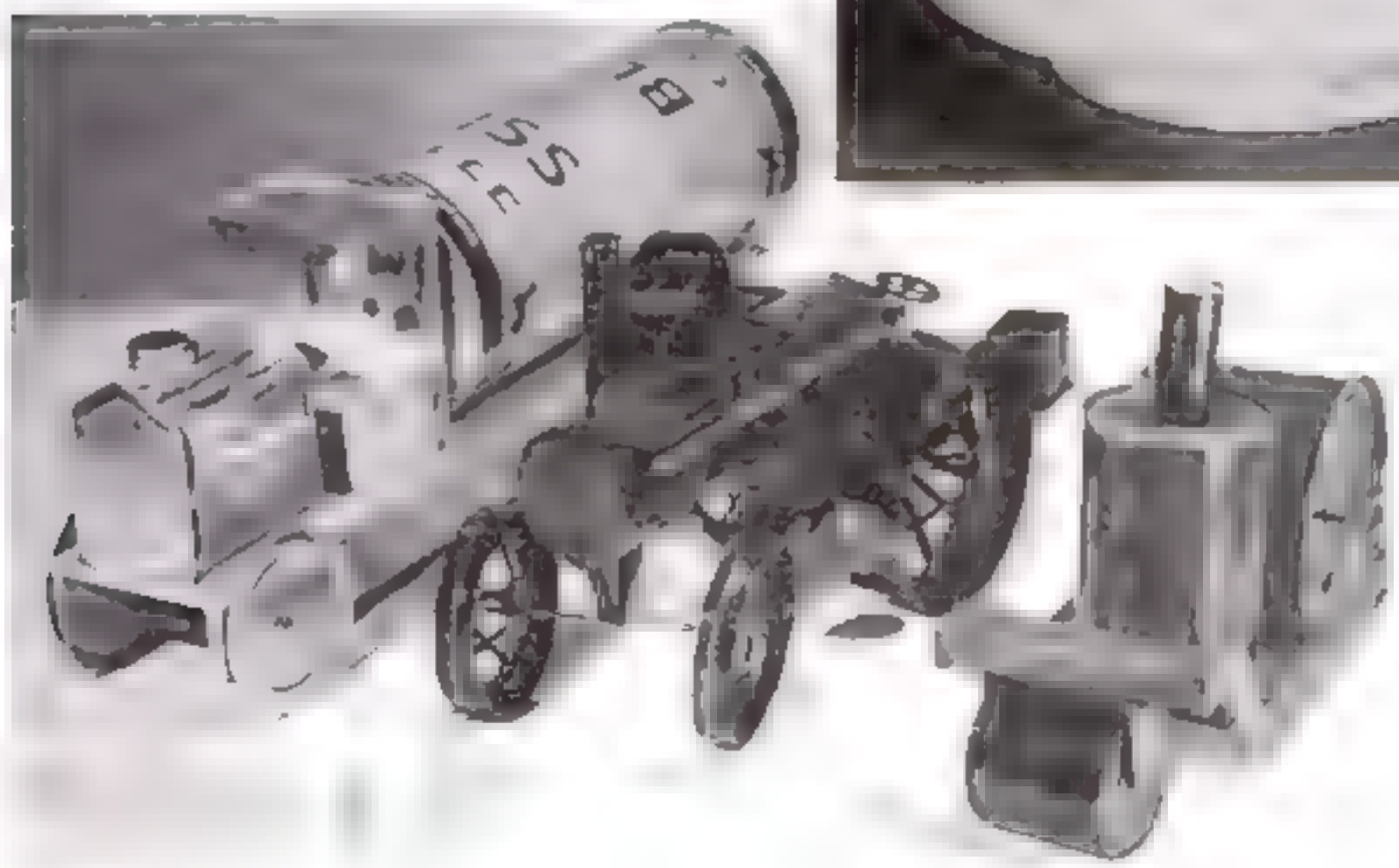
Fig. 7. Attention, all Scouts! It's not hard to make an arrowhead neckerchief slide from two thicknesses of tin

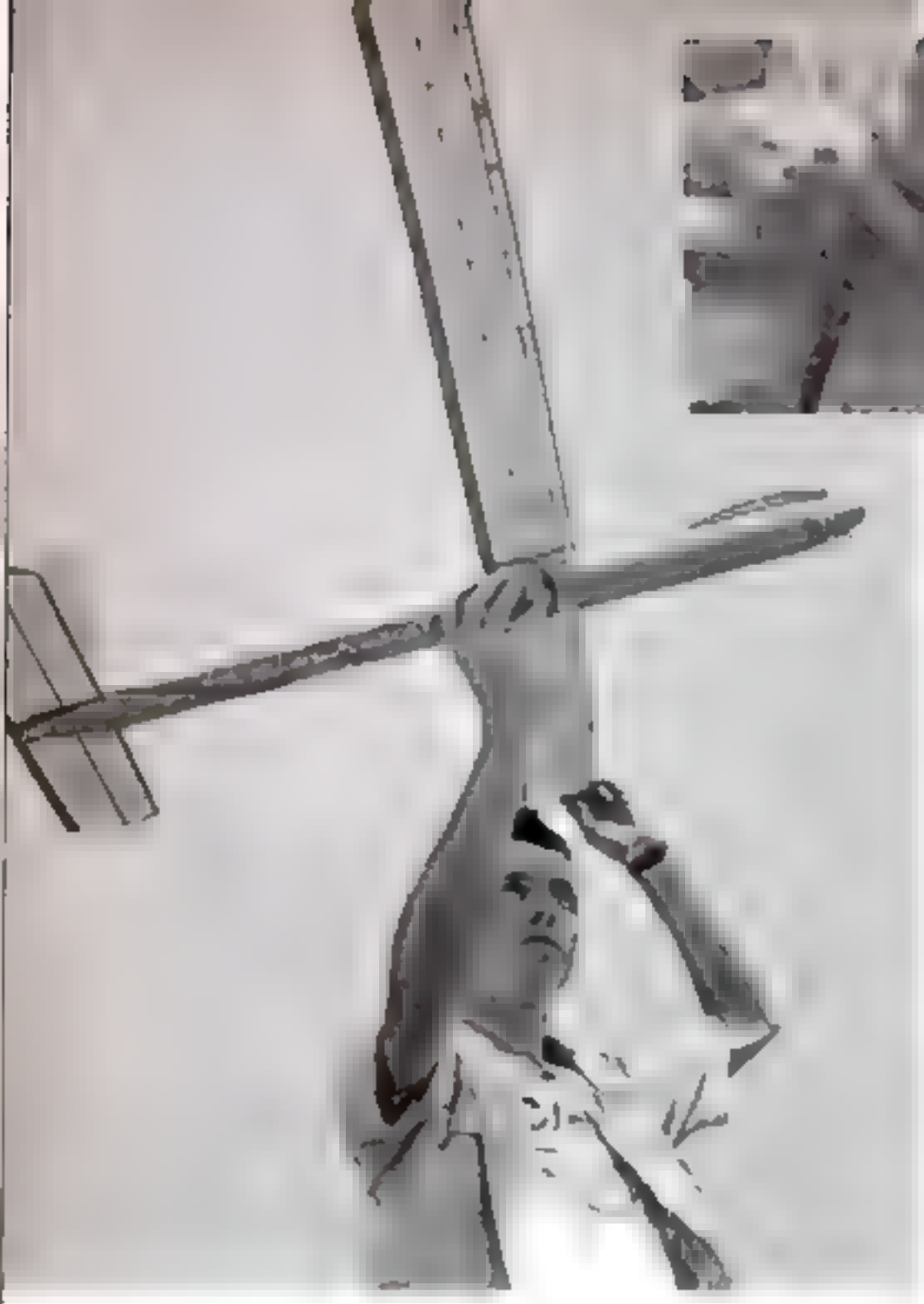
Fig. 6. Left, a picture frame made from a cocoa-can lid by Violet Hagie, Watertown, S. D. The ship model is by Harold Jackson, of Kankakee, Ill. H. C. Rose, of Carbondale, Ill., used a film pack in the frame at right

tops and bottoms of small cans. The seat is a wood block. Turn in all sharp edges.

Tin snips or an old pair of heavy shears, pliers, a drill and a few bits, and soldering equipment are the chief tools needed to make any of the projects illustrated. The tin plate is easy to solder and to paint. If it is left bright, clear lacquer will protect it from discoloration. It can also be electroplated with copper and other metals.

Fig. 8. Right, a new kind of coke box and server. Below, toys that roll—the kind children love—made of tin cans. The truck has four rear wheels





This wide-winged model illustrates the trend to the big ships which are giving some excellent performances in distance flying. The propeller-folding device in the close-up is a sturdy one, for this type of rubber motor is powerful

The Modern 300-Incher

By FRANK ZAIC

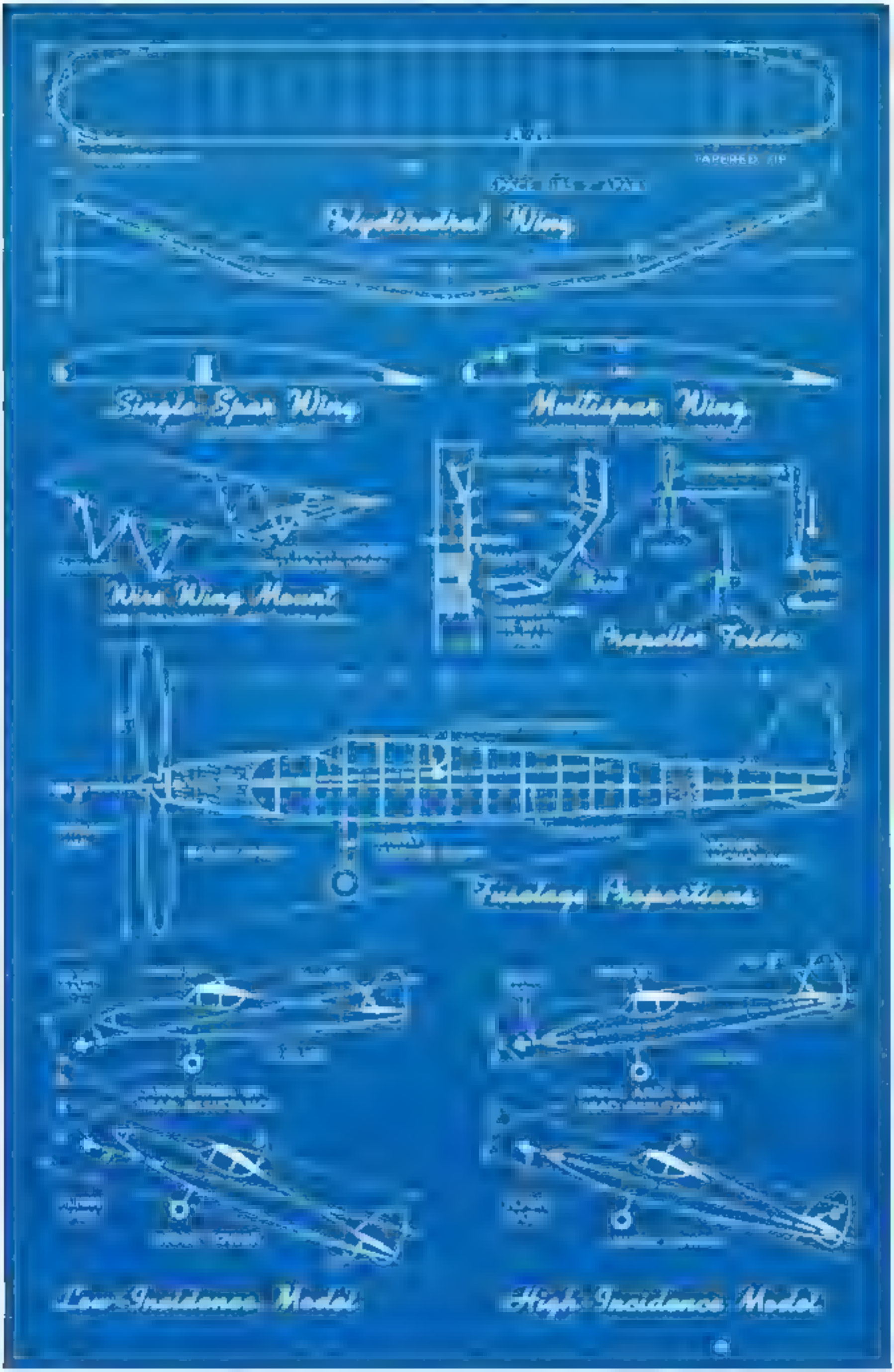
WITH planes shaping history, model making is in the foreground along with other aeronautical activities. Model designing is a compulsory part of pretraining by the Air Cadet League of Canada for prospective recruits of the Royal Canadian Air Force. England includes model flying in the program of the Air Training Corps, which has furnished 70,000 young men to the Royal Air Force. In the United States, the Air Youth Division of the National Aeronautic Association is organizing a large Junior Air Reserve for a like purpose. Thus model making progresses despite threatened shortages of rubber, balsa, tissue, and other imported items.

The present design trend is toward 300-square-inch rubber-powered models. Their excellent performance, due to the fact an airfoil becomes more efficient as its size increases, assures further advances. Perhaps the greatest single impulse toward big ships has been the Wakefield Cup competition ruling, which specifies a 200-square-inch design and a minimum weight of 8 oz.

These models can be kept in sight longer, and the weight of timers to bring them down is not prohibitive. This equipment can also be used to provide variable-turn control, thus permitting models adjusted for a tight circle to be set to fly a very wide circle under power and eliminating the critical period in high-powered take-offs.

A commercial kit or plans for a 300-incher would, of course, be a convenience, but a builder can design one for himself or enlarge a smaller design if he keeps in mind certain basic relationships. A good ratio between a wing's average width and its span is 1 to 8; thus, for a wing span of 48", the average width or chord should be 6". Another rule applies to polydihedral wings, such as in the drawings, which act rapidly in bringing or holding a model level. For them, use 1½" of dihedral for every foot of span; thus, a 48" wing should have 6" of dihedral under each tip. The sketch shows how to break up the two halves. Round tips will do, but tapered are more efficient.

Wing construction may be single-spar or multispar, and the undersurface flat or cambered. A flat undersurface produces good flights, but experts prefer the cambered. Likewise, the single-spar wing is easier for the beginner to notch and cover. Note in the multispar drawing the concentration of spars on the leading edge. It is possible


Biplane Wing
Simple Span Wing
Multispan Wing
Wire Wing Mount
Propeller Folder
Fuselage Proportions
Low Incidence Model
High Incidence Model

Out-of-sight flights of six minutes are possible with models like this. Bright, contrasting colors on the fuselage such as red and yellow, or black or blue to show against clouds, help in following them

that the ridges formed by them help in obtaining better lift and postpone stalls.

The fuselage is usually about one fourth less than the wing span—say 36" for a 48" span model. The cross section may be rectangular, either cabin effect—side stringers improve the shape—or turned on edge in "diamond" style. The simplest wing mount for a diamond fuselage is shaped from wire and cemented on as shown. Longerons should be fairly hard 5/32" square balsa strips. Sheet balsa on the front provides a good handgrip for winding or launching. The Cahill type of landing gear, if far enough back, may be short and still allow propeller clearance, as shown in the drawings.

Although the smaller models' standard stabilizer area of 40 percent of the wing will serve, 33 percent is adequate. Construction and tip outlines may be the same as for the wing, except that a flat undersurface is preferred as a camber may warp.

Rudder size is determined by so many things that it cannot be stated definitely in percentage of wing area. You may start with 12 percent and then observe the model under power and in a glide. An undersized rudder tends to develop right spins under power; an oversized one, left spins. Under low power a small rudder may also lead into a stall. After tests, make corrections by cementing balsa sheets on or cutting off the tip. A small fin is helpful in making turn adjustments or for use with a timer.

Just as wing area is needed to lift a plane, there must be enough propeller blade area to pull it. A double blade is preferred, for the single blade must turn faster to pull the same load and will develop more "slip." For the 300-incher, an 18" propeller carved from a 2" by 2½" block is suitable. A sturdy folding device is needed, since the motor uses about 40 strands of ⅛" rubber or 20 of ¼". The one in the drawings, made by Dick Korda, 1939 Wakefield Cup winner, holds up well.

Wings are usually set at an angle of 2 or 3 deg., and tails parallel to the fuselage, or at zero incidence, but better results are had with an incidence of about 8 deg. on the wing and 6 deg. on the tail. This is true because, since all models are adjusted to fly close to the stalling point—that is, in a very slow glide—wing and tail settings remain the same for either climbing or gliding. The drawings show how the fuselage of a low-incidence model plows at an angle under power and in glide, while a high-incidence model flies directly into the air stream. With low-incidence settings, a diamond fuselage has less drag than the cabin type, but with high incidence there is little difference.

Propeller down-thrust may be obtained by offsetting the nose plug. With the wing on the fuselage, the center of gravity is slightly above the center of the rubber motor. The propeller thrust line should pass through this point. A high wing raises the center of gravity, making more down-thrust necessary, and has no advantage, for a large stabilizer gives sufficient control.

Having found a "victim," club members bind his "injuries" with first-aid splints made in their workshop

Traction Splints and Stretchers

PACIFIC COAST CLUB CONSTRUCTS EMERGENCY FIRST-AID EQUIPMENT

By CHARLES HENRY HUNT

President, Long Beach Homecrafters

HOME craftsmen who wish to help Uncle Sam in his civilian defense program may well follow the example of the Long Beach, Calif., Homecrafters. This club, one of the many clubs affiliated with the National Homeworkshop Guild, has made several hundred traction splints and stretchers to be placed in Red Cross warehouses for emergency use. Such first-aid necessities are excellent projects not only for clubs, but also for home-shop owners and school woodworking classes.

It is advisable to consult local Red Cross officials to determine just what equipment is most needed. The splints and stretcher illustrated have been used and approved by Red Cross instructors, and should be acceptable to all local chapters.

Traction splints. These splints alleviate pain and shock and keep broken bones separated and in approximate alignment, thus preventing further laceration of tissue and shortening healing time. Traction splints are standard equipment for Red Cross, Army, and Navy first-aid use, and they are generally made of metal. Well-made wooden splints, however, are thoroughly satisfactory and cheaper, and the material is plentiful.

An adjustable splint of the type shown furnishes in one unit all the needed parts for a traction or a conventional splint for arm or leg injuries. Notches hold the ties of cravat bandages and are so spaced that the parts can be lashed together if the wing nuts should be lost. The end notches hold ties for sling and traction hitches. One piece *A* is used for an elbow or knee fracture; two such pieces, one on each side, serve for leg splints. Two short pieces *B* form splints for the upper or lower arm.

The entire unit is used as a traction splint as shown in the photograph above. Both pieces *A*, adjusted to the proper length and clamped, are tied on the injured member, which is supported as shown on the two pieces *B*, these being crossed, lashed together with a cravat bandage, and slipped into one of the notches in *A*. *(Continued)*

Shorter than regulation size, this stretcher will fit into a station wagon or other temporary ambulance. It folds for storage in little space

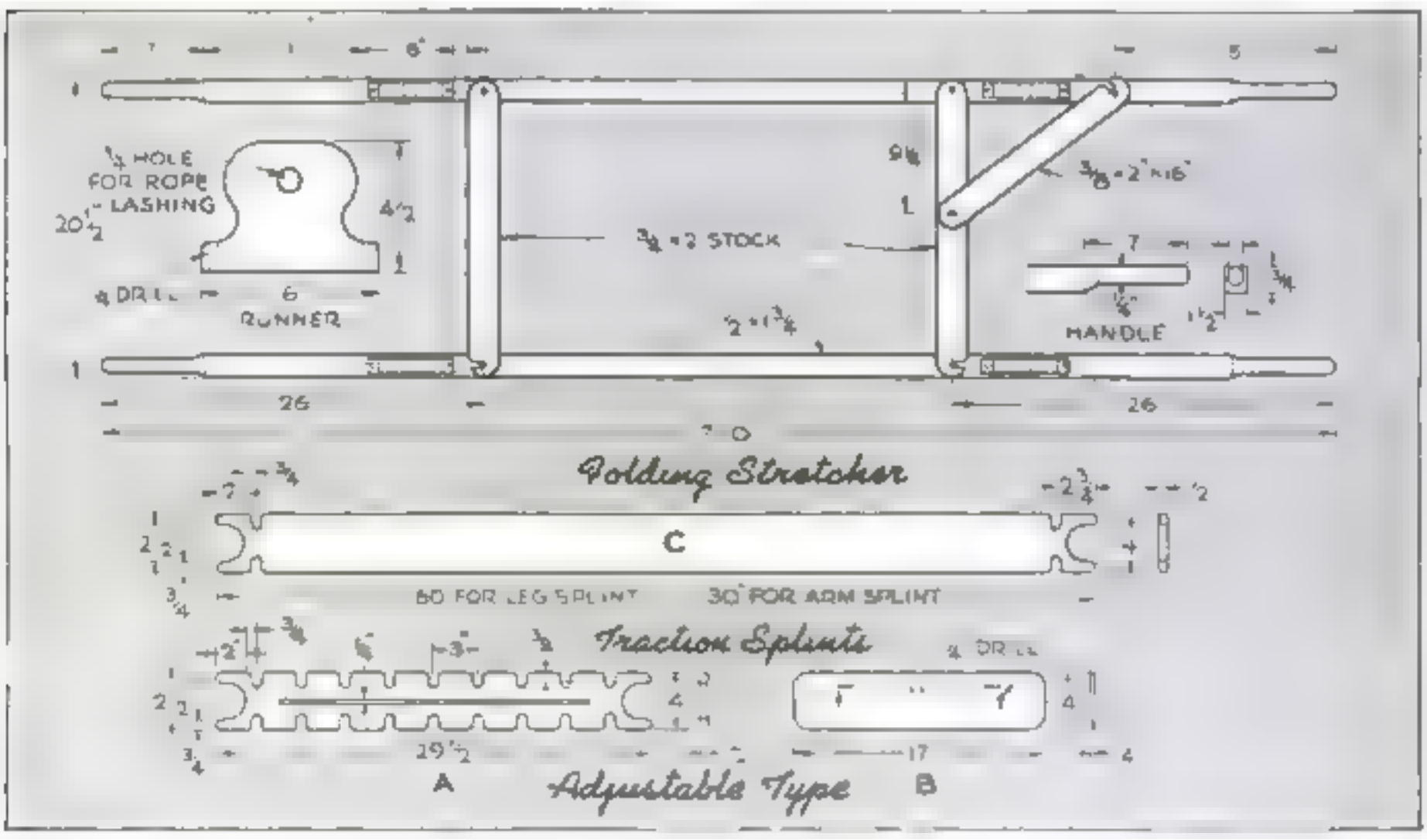
Use plywood for both units, cutting two pieces *A* from ½" 5-ply material and two parts *B* from ¼" or ⅛" stock by band-sawing to the outside outlines. Run in the ¼" wide slot in *A* on the circular or jig saw. Bore a ¾" hole for each notch on a line ⅝" from the edge; then band-saw to the holes. Finally, run all the edges on the shaper against a quarter-round cove knife, turning the piece over to shape the other face, or use a wood file and sandpaper. In the pieces *B*, drill two ¼" holes as shown. Thoroughly sandpaper all the parts. Sandwich both of the long members *A* between the two plates *B* and insert two 1¾" by ¼" stove bolts to hold them together, using a washer and a wing nut on each.

For a fixed traction leg or arm splint *C*, made much the same way, use ½" pine or hardwood.

Folding stretchers. Though not as simple to make, folding stretchers are much better than the other types if they are to be stored where space is at a premium. They should be strong and light and be equipped with runners on which they can be pushed into an ambulance. For emergency use, they should be shorter than the regulation length of 7' 6" to go into delivery trucks, station wagons, or other makeshift ambulances, and no wider than 20¼" to fit two abreast.

Make two poles of straight-grain spruce, oak, maple, or hickory. Band-saw the handles to size, and fashion them on the shaper or with a spokeshave. Runners are band-sawed from maple, and attached with 3" by ⅛" carriage bolts. Cross braces are of ¾" by 2" stock pivoted and notched; the short diagonal brace of ⅝" stock. Bolt the braces on one side with 3" carriage bolts and use wing nuts to clamp the notched ends.

Stretch duck canvas over and around the poles, nailing it fast with large-headed tacks spaced about 1" apart. The wooden members should be finished with stain and two coats of varnish and the handles rubbed smooth.



HW 178

Kits

FOR FIRST-AID INSTRUCTORS

By PARK A. SOULE

President, Ashland Home Workshop Club

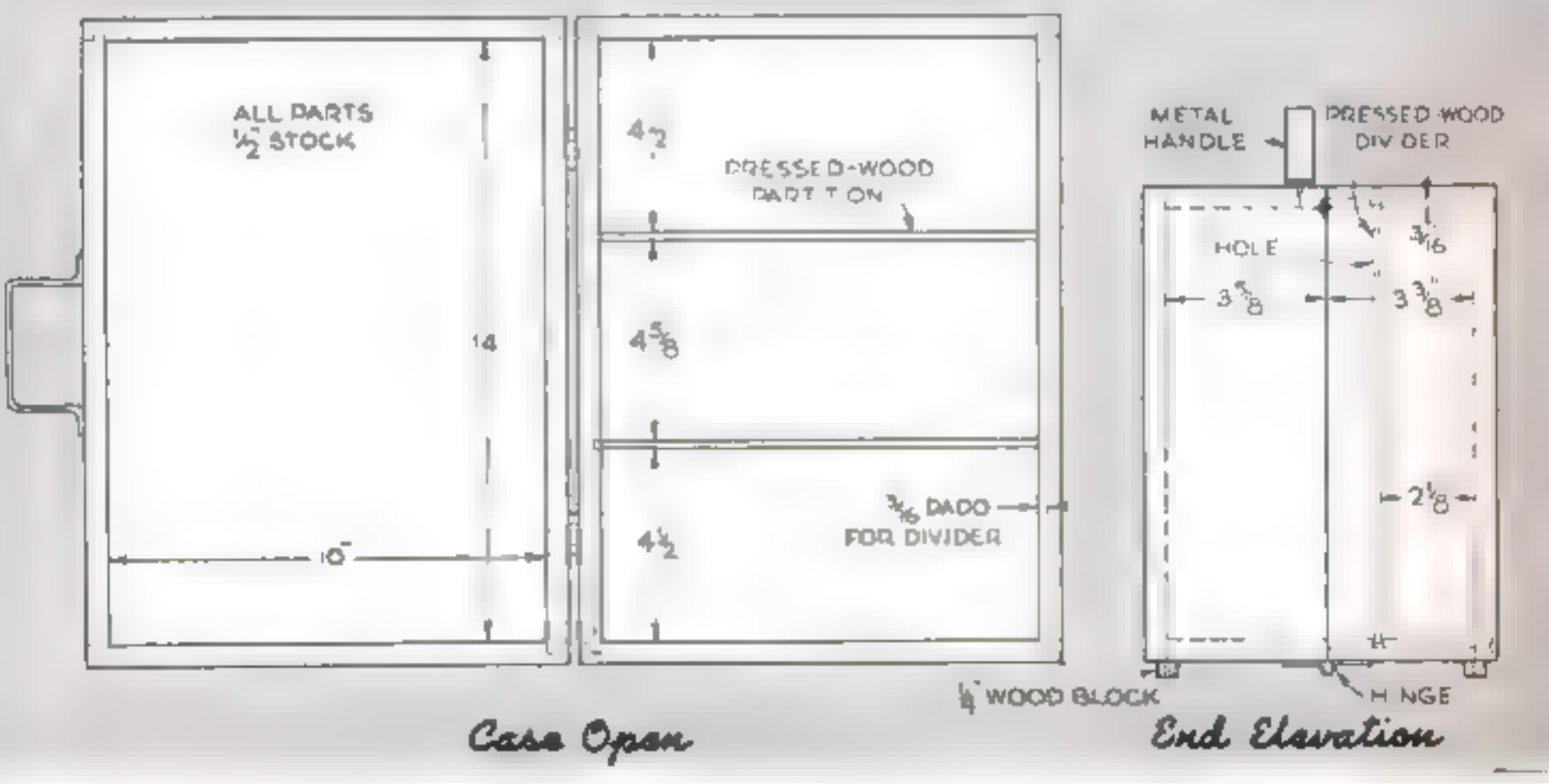
One side of this kit will hold 30 triangular bandages, and the other, partitioned into compartments, contains traction grips, splints, bandages, and a first-aid manual

MEMBERS of the Ashland (Ohio) Home Workshop Club, an affiliate of the National Homeworkshop Guild, have turned their skill to civilian defense by making and presenting to their local Red Cross chapter a number of first-aid kits, as well as splints and other necessities. The boxes, designed for the use of first-aid instructors, hold 30 cravat bandages in one compartment, and traction grips, splints, bandages and a first-aid manual in the other.

For the body of such a case, ½" wood is quite suitable. Pine will serve, although hardwood is, of course, more durable. Simple screwed or nailed butt joints may be used, as the front and back panels make the framework quite rigid, but if power equipment is available, rabbet-and-dado joints should be preferred.

The often-used trick of building a closed box, and then sawing it apart to produce a perfectly fitting lid and case, may be employed to advantage. The 3/16" deep dadoes for the dividing panel and the partitions must, of course, be cut before the box is assembled. Those for the partitions should be stopped short of the parting line and finished by hand after the case is cut apart. Pressed composition wood is used for the panel, which rests on the partitions and is sprung into the long grooves.

The two parts are hinged together and fitted with a luggage handle or drawer pull and two substantial catches. Luggage buttons or wood blocks should be attached to the side opposite the handle to afford clearance for the hinges and to prevent splintering of the corners when the case is set down. Paint both the inside and the outside white, and stencil on the standard Red Cross insignia and lettering, if desired.



HW 179

KEEPING THE HOME

When table linen is to be used for more than one meal, the tablecloth can be kept cleaner at the place set for a small child by using a square of ordinary household waxed paper under the plate. The paper is fairly inconspicuous to guests, will catch spilled drinks and particles of food before they spot the cloth, and will save much washing

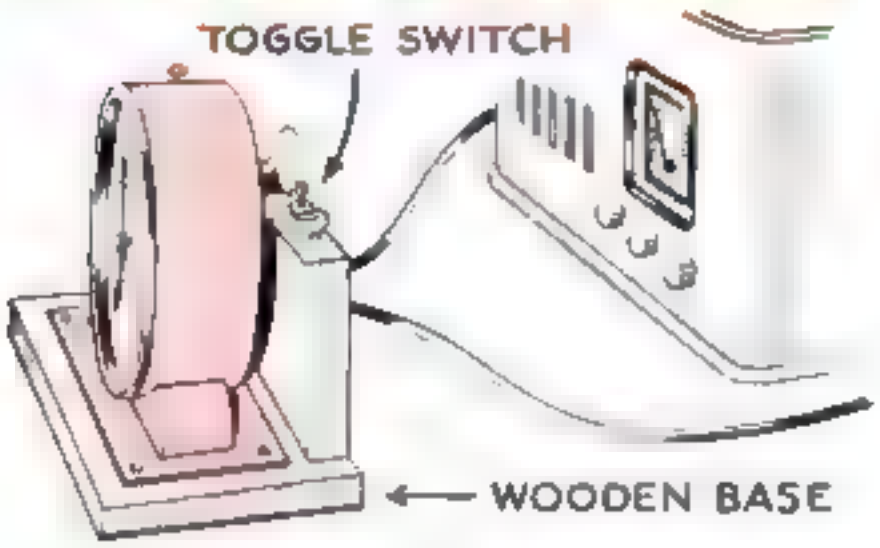
Basement clotheslines that can be pushed up out of the way when not in use may be made from a few pieces of 1" scrap lumber or ¾" plywood bolted to joists as shown above, and a pair of eyebolts with wing nuts and a length of galvanized wire for each line. The wire should be pulled as taut as possible with the eyebolts extended to their full length to allow for tightening from time to time as the line stretches. Use of galvanized wire will prevent rusting from the wet clothes

Gripping surfaces of tweezers that don't hold properly may be trued by working them over a piece of folded abrasive paper

Half of a spring clothespin cut down, then attached to a piece shaped from wood, forms a handle extension for measuring spoons

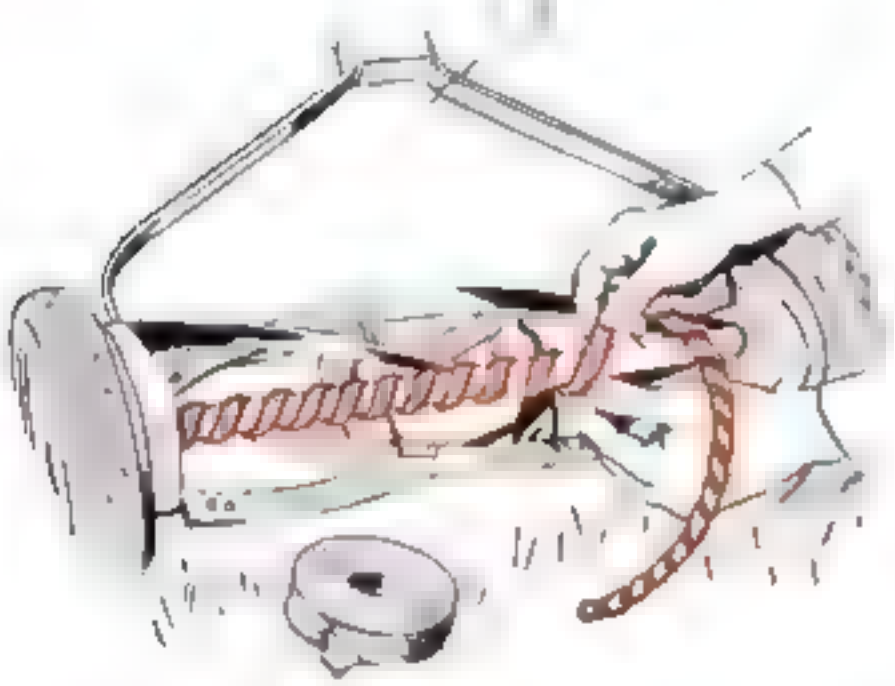
A sharp knife inserted in the edge of a piece of corrugated cardboard can be taken safely on a picnic or camping trip

SHIP SHAPE

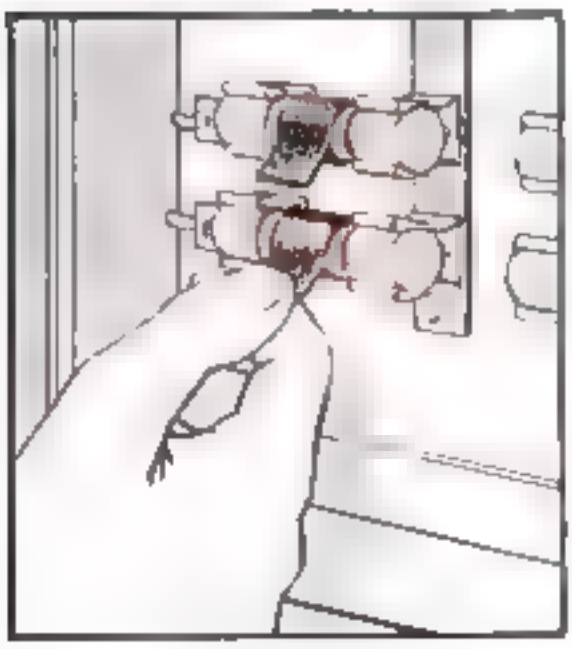


Waking insurance can be had by supplementing the alarm clock's ring with the radio. Fix the clock to a base so its unwinding alarm key will throw a toggle switch connected in the radio power line

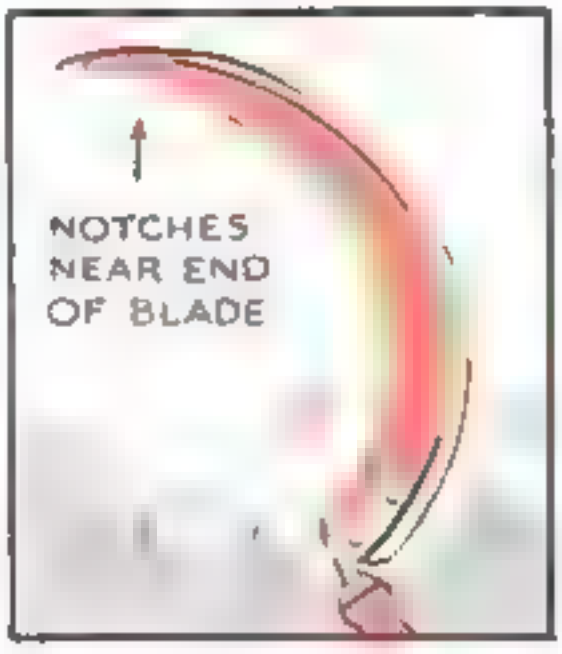
Nailed to the wall as shown, a section of casing from an old tire that is beyond repair will keep a milk bottle from being blown over or knocked off the porch. To serve as a cushion and prevent breakage when the bottle is set down, a circular pad of rubber or soft material may be attached to the floor before the casing is nailed fast. The guard may be painted to match the house woodwork



The risk of harming trees and shrubs with a lawn mower can be avoided by wrapping the bumper bar with a spiral of rubber such as a telephone-cord guard. Fasten the ends down with friction tape



Insulated tape, wrapped at the center of cartridge-type fuses, provides a safe grip for pulling them from clips



Notches ground or filed in the end of a sickle enable grass to be cut close to any obstruction. Sharpen the teeth from each side

Labels can be removed from old bottles quickly by soaking them in water for a moment and then holding the bottles near a heater

Automatic Train Control

By DAVID MARSHALL

ON THE grown-up railroads, "A. T. C." is a common expression. It means automatic train control—an arrangement to shut off steam and release the air, thus applying the brakes, if a locomotive should pass a *stop* signal unattended. It takes a variety of forms, but usually there is an electrical track device abreast of every signal and a corresponding unit aboard the locomotive. With a signal at the *stop* indication, the track device maintains a magnetic field to which the other unit reacts.

In today's A. T. C. system, the control does not at once stop the train; it first blows a warning whistle in the cab and its further operation can be canceled only by "answering" the whistle—pressing a button, pulling a cord, whatever the system requires. If not answered, the device stops the train.

In model railroading, we stick to the older form. Trains come quickly to a halt before every *stop* and automatically resume motion when the signal rises to the *clear*. With A. T. C., therefore, trains may operate in sequence wholly unattended.

REPEATER RELAYS. Since A. T. C. is a branch of signal engineering, we refer to Fig. 1, in which all that we need to know about automatic signaling for the present is made clear. The sketch deviates from ordinary practice by having two track relays for every block instead of one, but the principle remains the same; each additional relay, hooked up in parallel with the regular relay, only repeats the action of the first.

The No. 1 relay and its repeater both are energized, because the No. 1 block is occupied, and current is flowing from the track battery to the common rail, through the wheels and axles of the train to the control rail, and through the relay coils back to the battery. The No. 2 relay and its repeater are inactive, because their block is vacant.

POWER CIRCUIT. In Fig. 1 we have the track and signal circuits both using the common rail. In Fig. 2, we introduce a third rail and a third circuit, also grounded through the common rail. For the sake of clarity, we leave the signal circuit out. The new element is the power circuit, in which current flows from a transformer or other source to the third rail, through the motor windings of the locomotive to the common rail, and back to its source.

Observe that the third rail is sectionalized, every section corresponding to a block and all sections mutually insulated. The power flows to each section through a separate switch—preferably a toggle switch mounted in place upon a diagrammatic control map of your whole railroad. With such a board you can operate trains in every block separately.

AUTOMATIC CONTROL. Three blocks are embraced in Fig. 3. The sketch is an expansion of Fig. 2, the third rails are further sectionalized, and the repeater relays are put to work. We have cut off and insulated a short end of every third-rail section just ahead of the following block and established a connection by which this short end is normally energized from its own main segment—a circuit through the contacts of the repeater relay belonging to the next block *to the rear*. Let us clarify this.

Signal designations always run counter to the flow of traffic, for the excellent reason that the signals themselves must face oncoming trains and therefore look backward along the track. A train thus is always headed toward the rear of the block it occupies. In Fig. 3, the No. 2 block is to the rear of No. 1, No. 3 to the rear of No. 2. So, too, the short insulated segment is at the rear end of each block.

As things stand in Fig. 3, a train could pass from the No. 1 block to No. 2 because the latter is vacant. The No. 2 relays are not energized; the signal is at the *clear* and the rear end of the No. 1 third rail is receiving power via the armature of the No. 2 repeater relay. But a train could not leave the No. 2 block, for the No. 3 block is occupied. The No. 3 repeater relay is energized, the circuit is broken, and the rear end of the No. 2 third rail is without power. The signal guarding the No. 3 block is at the *stop*, and a train approaching it will come to a halt for lack of power. But the instant the train in the No. 3 block pulls out of it, the No. 3 repeater and signal relays become inactive, the signal will go to the *clear*, the power circuit of block No. 2 will be closed, and the train will move on.

A final word of warning. Every insulated rear end must be short enough to let each train roll to a stop just before it reaches the next signal, yet not short enough for a free-running locomotive to coast across.

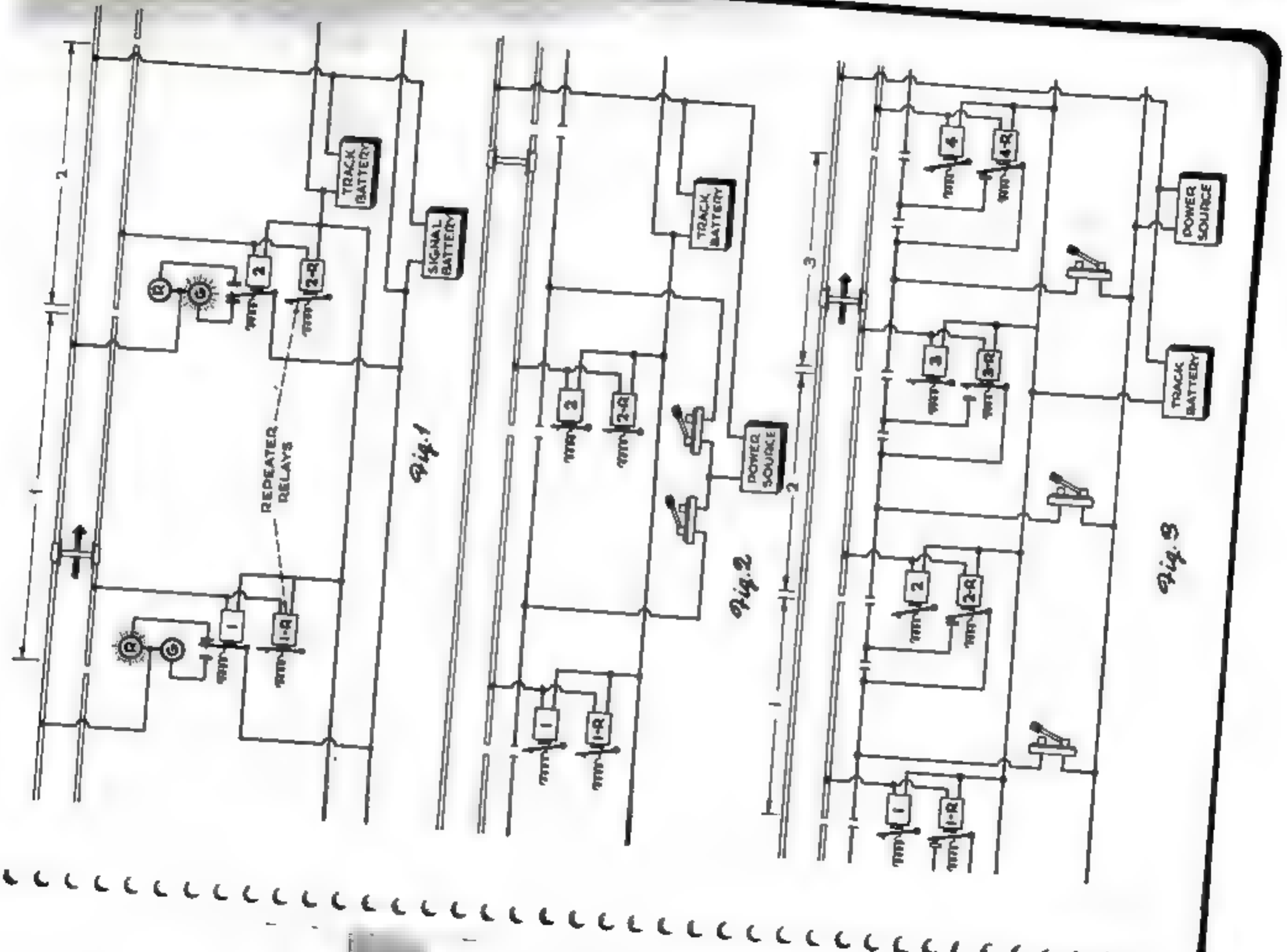
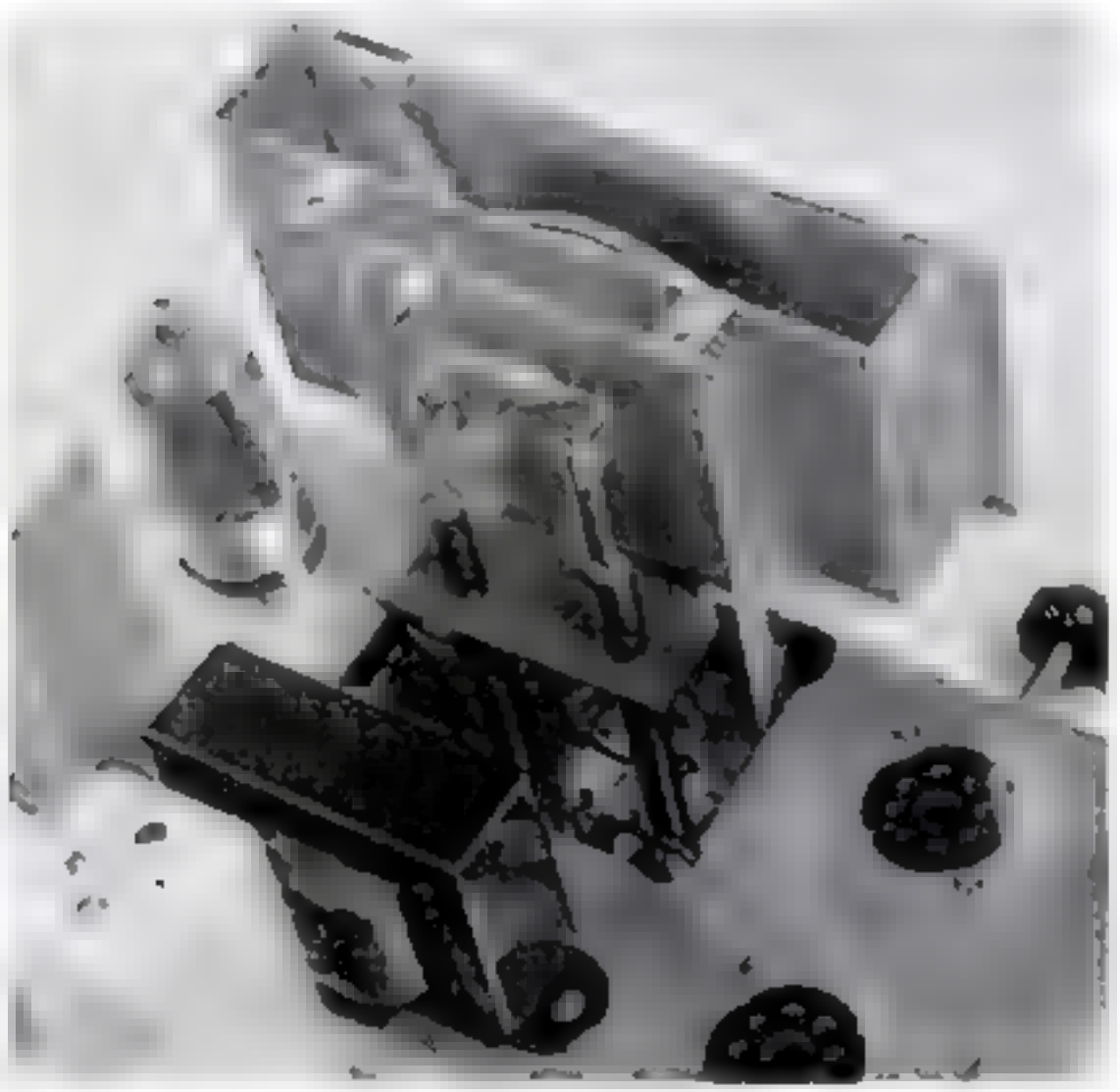


Fig. 1

Fig. 2

Fig. 3

Priority Receiver USES NEW-TYPE TUNING UNIT



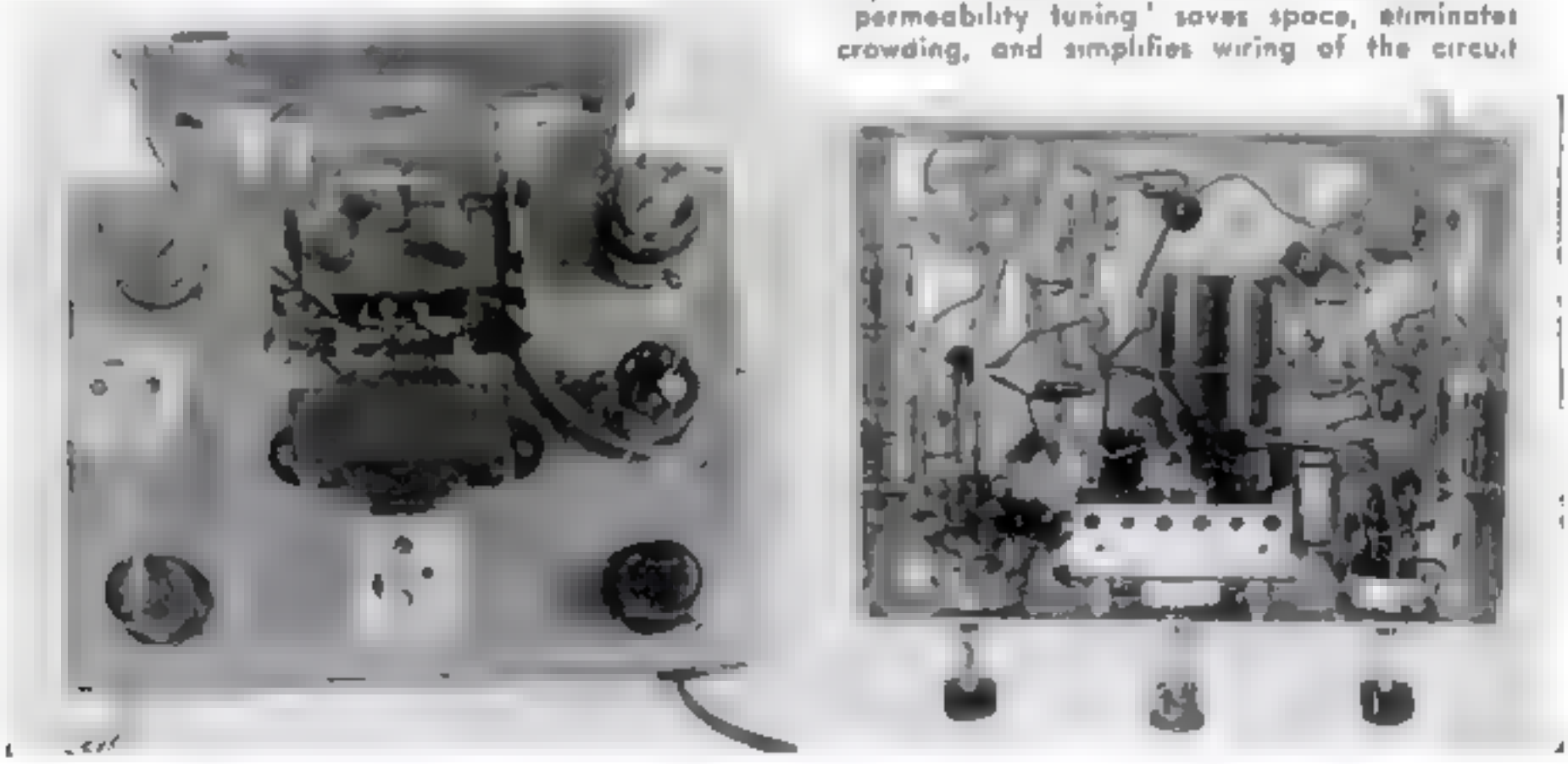
Iron cores moving in antenna and oscillator coils tune this set

WITH tuning condensers becoming increasingly scarce, a timely interest attaches to this five-tube superhet which tunes by varying the induction of the antenna and oscillator coils. A core of compressed powdered iron about 5/16" in diameter and 2⅛" long moves in and out of each coil. These iron cores are ganged and regulated by the horizontal tuning dial which, incidentally, is accurately calibrated in kilocycles. The tuning range of this set is similar to that of any standard-type receiver using variable condensers—550 to 1,500 kilocycles.

Tubes used are a 12A8-GT as a pentagrid converter; a 6S7 as an I. F. amplifier tube; a 12SQ7 as double-diode detector, AVC, and first audio amplifier tube; a 35L6-GT as power pentode tube capable of an output of 1¼ watts without overloading, and a 50Z7-G as a half-wave rectifier tube. The heaters of all these tubes are connected in series with a total voltage of approximately 117 volts, making a series heater resistor unnecessary

Permeability tuning, as this new method is called, makes it possible to save space, as the space taken up by the new tuning unit behind the tuning dial is approximately half that required by a two-gang variable condenser. And again, since the tuning unit already contains the antenna and oscillator coils, a further saving of space both above and below the chassis is obtained. Notice how well-spread the

Top and bottom views of the chassis show how permeability tuning' saves space, eliminates crowding, and simplifies wiring of the circuit

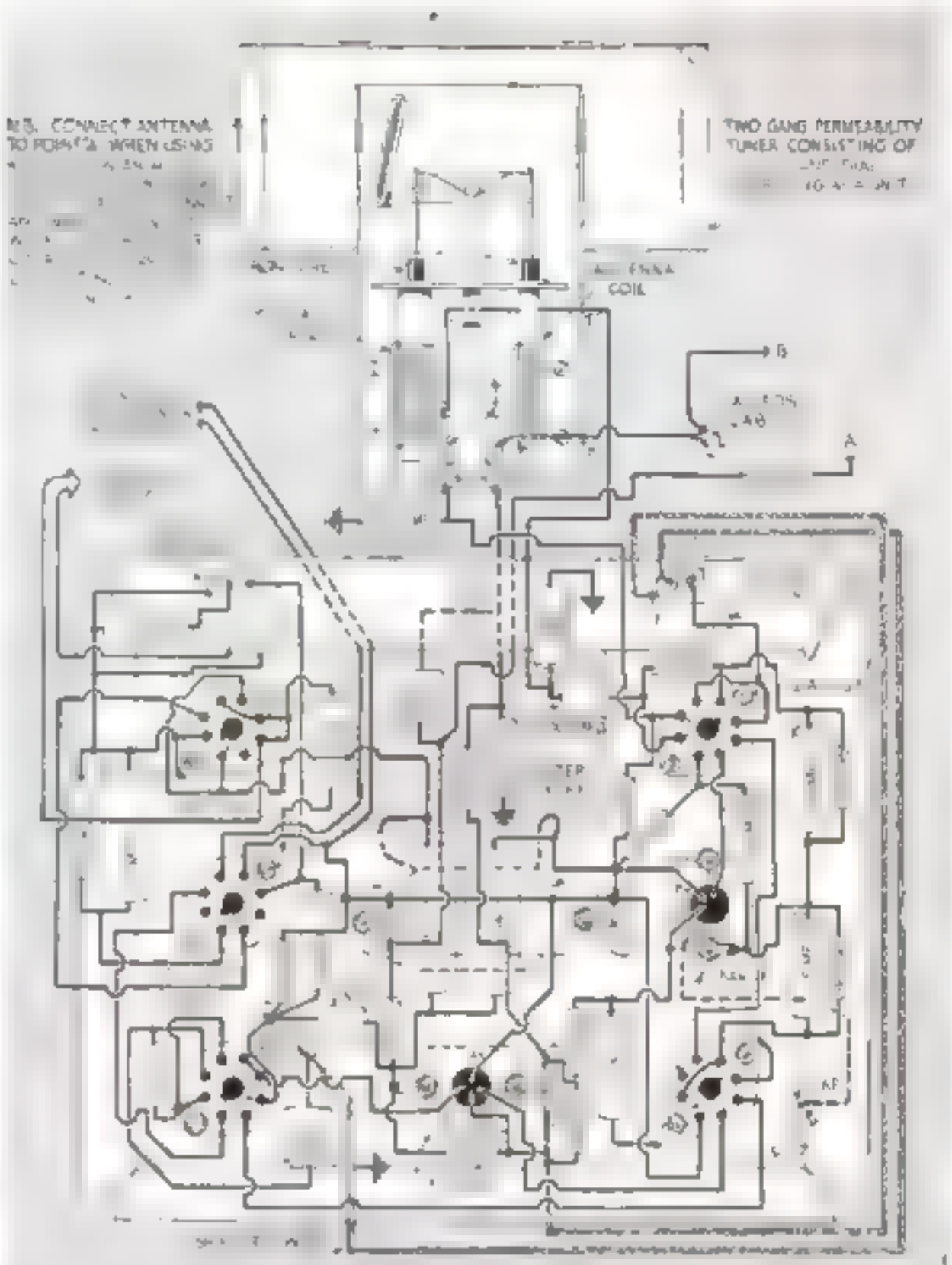


By
ARTHUR C. MILLER

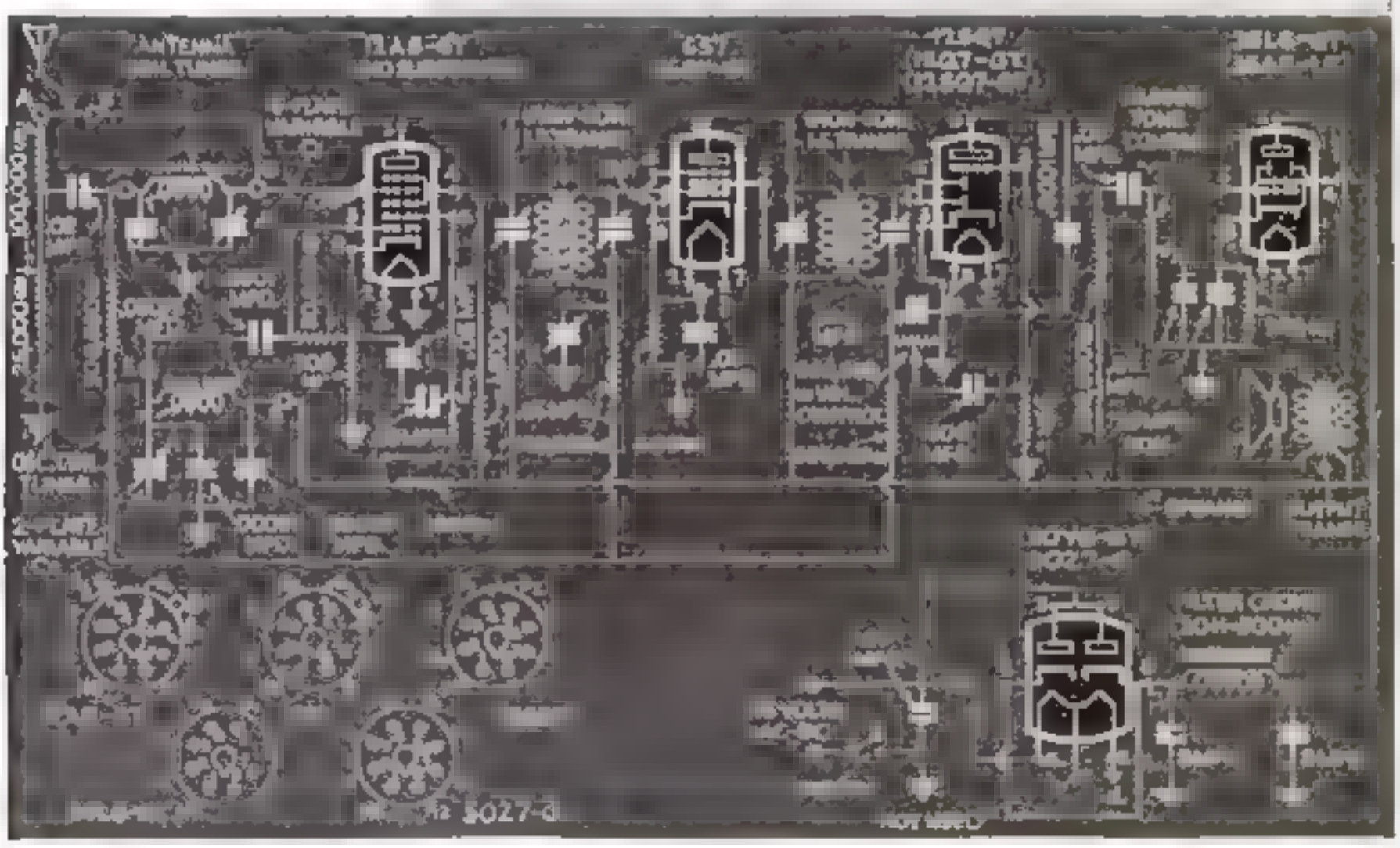
• •

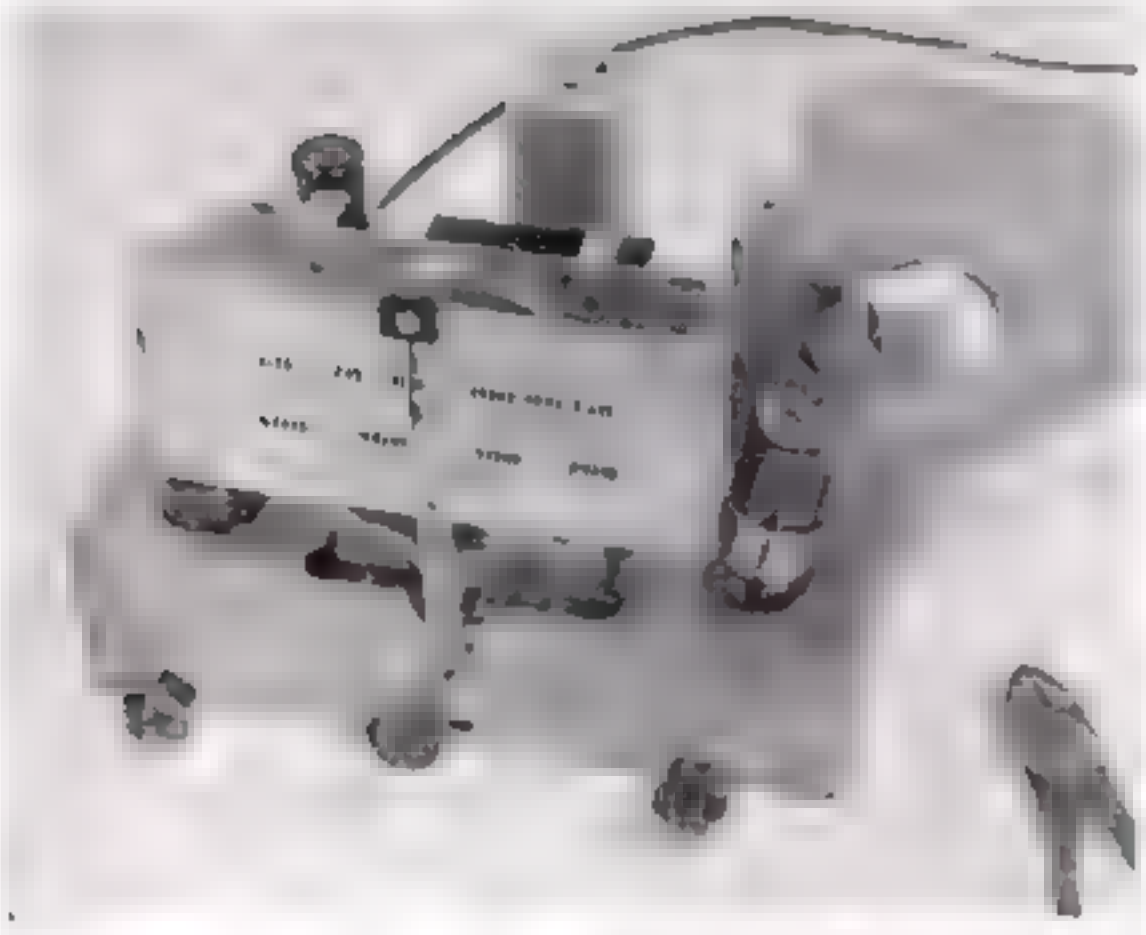
different components are above the chassis—no crowding and bunching The same holds true for the underside portion of the chassis. It makes the set extremely simple to build and wire

The war may make it difficult to obtain the exact tube type shown in the parts list. To give the reader as wide a choice as possible, we have given, on the wiring diagram, alternative tube types. The final results will be the same, as the set will operate satisfactorily with any of the tube types listed. The socket connections in most cases will be different For instance, the 50Y6-GT rectifier tube has its heater brought out to pins Nos. 7 and 2 instead

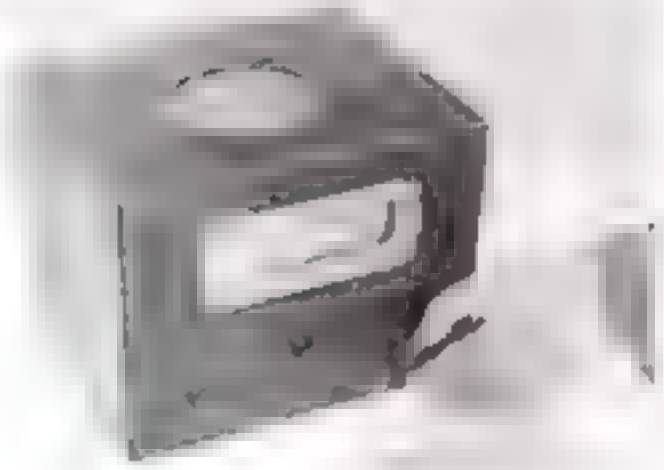


Alternative tube types given in the wiring diagram below may be substituted if those first listed are unobtainable



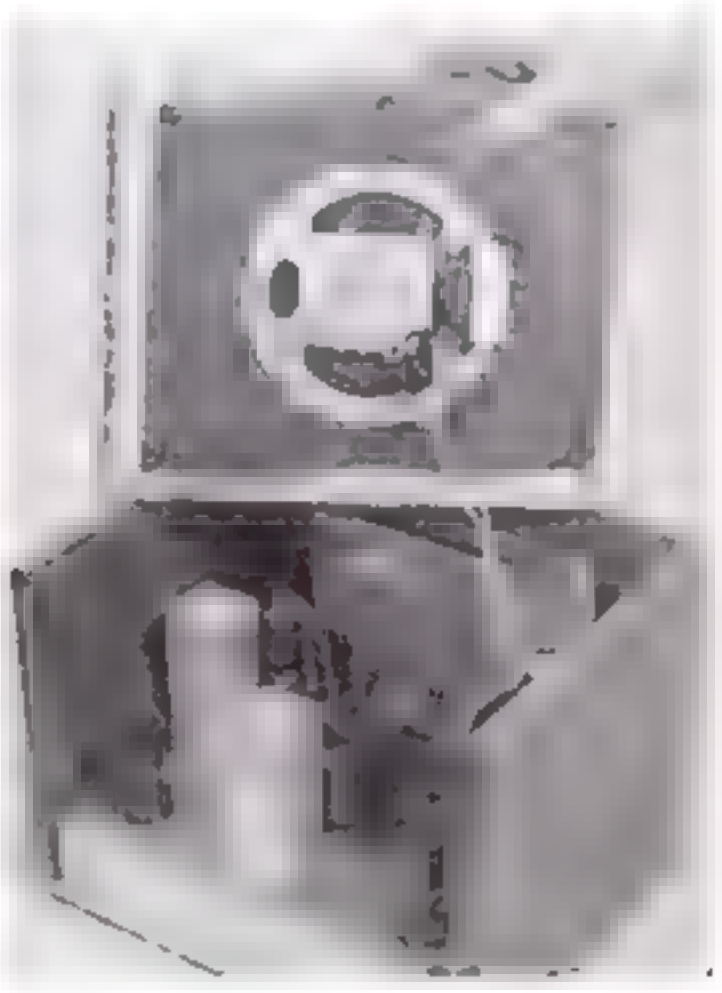


The horizontal slide-rule dial is calibrated in kilocycles. Tube being put into its socket in photo is the 12A8-GT



Tuning is easy. Left-hand knob turns set on and off and controls the tone. Right-hand knob is volume control

Cabinet cover, below, serves as a baffle for the 5" P.M. speaker. The back is left open for ventilation



of Nos. 6 and 2 as in the case of the 50Z7-GT. If the 35A5-LT is purchased, be sure to buy a "loctal" socket for it instead of an "octal" socket.

Volume is controlled by the ½-megohm (500,000-ohm) variable resistor. Tone is controlled by a 50,000-ohm variable resistor and 02 mfd. tubular paper condenser connected in the grid circuit of the 35L6-GT. This arrangement provides an excellent method for artificially boosting the bass notes. It also helps in reducing static by decreasing the value of the high notes.

In order to make the mahogany cabinet as compact as possible, the 5" permanent-magnet speaker is mounted on top of the cabinet directly over the center of the chassis, facing upwards. It is a good idea to have the lid of the cabinet removable; otherwise it will be impossible to slide the chassis in and out of the cabinet unless the speaker is first removed, since the dial will not clear it. Of course the height of the cabinet could be increased, but this was not found as practical a method, as it would tend to unbalance the general appearance of the cabinet.

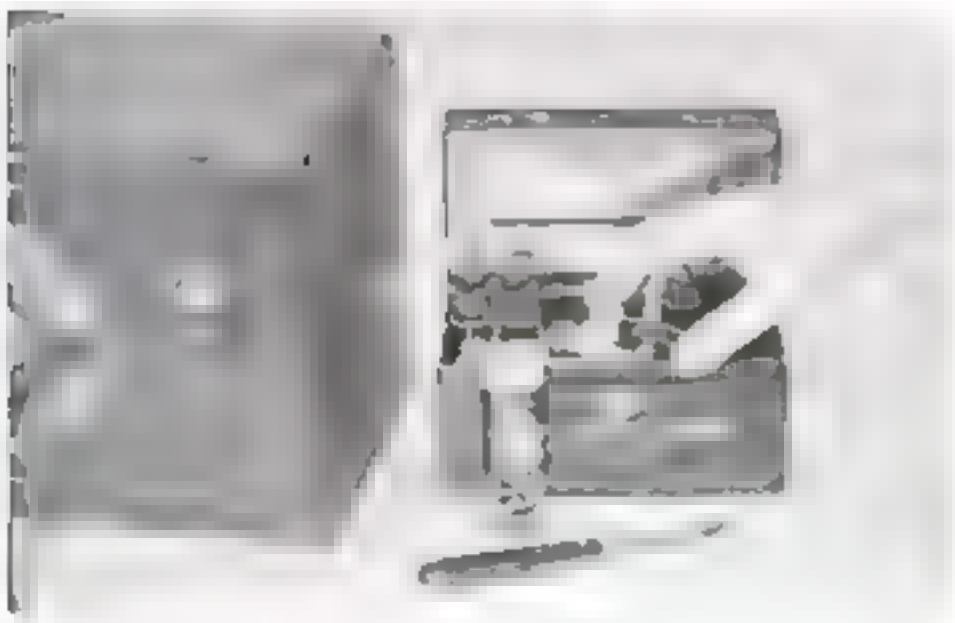
It will be noted that two holes are drilled in the front of the chassis just below the center of the tuning dial. These are for adjusting the two trimmer condensers of the tuning unit.

In setting the tuning dial, it should be borne in mind that with the cores of the antenna and oscillator windings moved all the way out, the set is tuned to the 1,550-kilocycle end of the dial.

LIST OF PARTS

- Permeability tuning unit (with trimmers C_3 and C_4).
- P. M. speaker 5".
- Universal output transformer
- Iron-core I F. transformers, 456 kc. (two).
- Filter choke, 20 henrys, 500 ohms.
- Line cord and plug, 9'
- Volume control, 500,000 ohms.
- Tone control and switch, 50,000 ohms.
- Cadmium-plated chassis, 2" by 7" by 9".
- Octal tube sockets (five).
- Paper tubular condensers: .05 mfd., 400 volt (six); .02 mfd., 400 volt.
- Mica condensers: .0001 mfd (three); .00033 mfd.; .00075 mfd.;.00007 mfd.;.002 mfd.; 006 mfd.
- Electrolytic condensers: 8 mfd. 450 v. (two); 25 mfd., 50 v.
- Carbon resistors: ⅛ watt, 500,000 ohms (two); ½ watt, 300,000 ohms; ½ watt, 2 megohms; ⅛ watt, 100,000 ohms (two); ½ watt, 50,000 ohms; ⅛ watt, 1,000 ohms (two); ½ watt, 20,000 ohms; ½ watt, 400 ohms; ½ watt, 300 ohms; 1 watt, 200 ohms.
- Cabinet, 8" by 8" by 10¼".
- Tubes: 12A8-GT, 6S7, 12SQ7, 35L6-GT, 50Z7-G.

Servicing Your Radio—PART 4



You can get a repair kit for fixing up your old cabinet

Deep scratches and dents are filled with stick shellac

. . . while slight ones are removed by a special polish

French polishing can be done with new synthetic materials

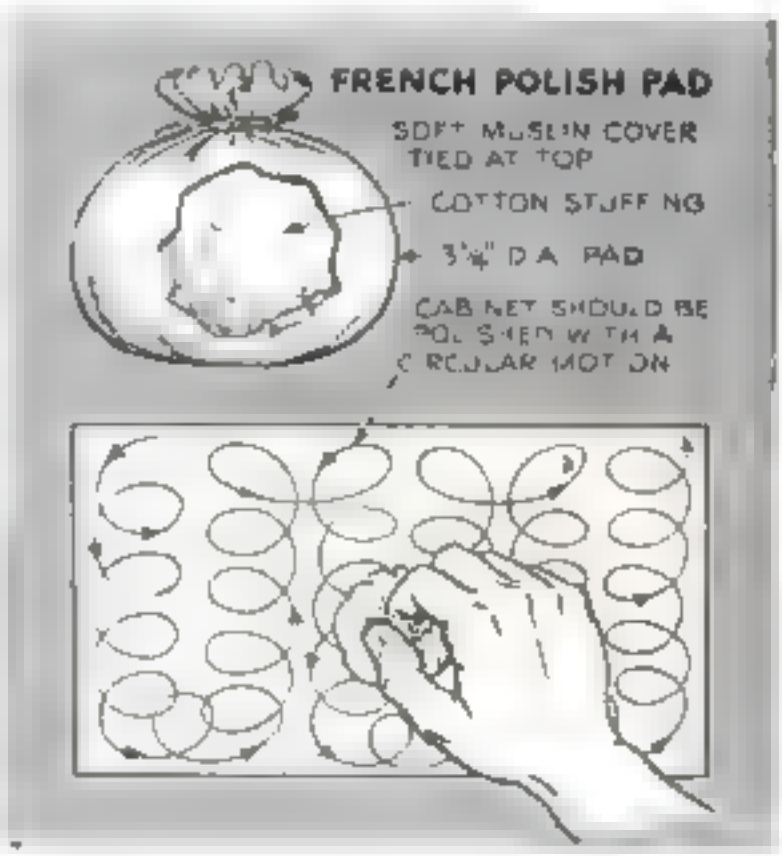
. . . and rubbing with fine steel wool gives a satiny finish

MANY radio cabinets today are in sad need of repair. The old finish has peeled off in places, nicks have been made in the wood, and maybe a few scratches have appeared.

Various kits are now on the market which will enable even an inexperienced person to patch up anything from a small scratch to a bad dent. First take the spatula which comes with the kit and heat it over the alcohol lamp. With the heated spatula melt a shellac stick cement of the proper shade and color into the hole, scratch, or dent. Once the imperfection is filled, it is smoothed off as well as possible with the spatula. The high spots are scraped off with a razor blade or sandpaper, and then rubbed down with fine steel wool and polished. Care should be taken not to injure the surrounding finish. Always make sure the spatula is clean and *never* use matches or a candle to melt the shellac stick.

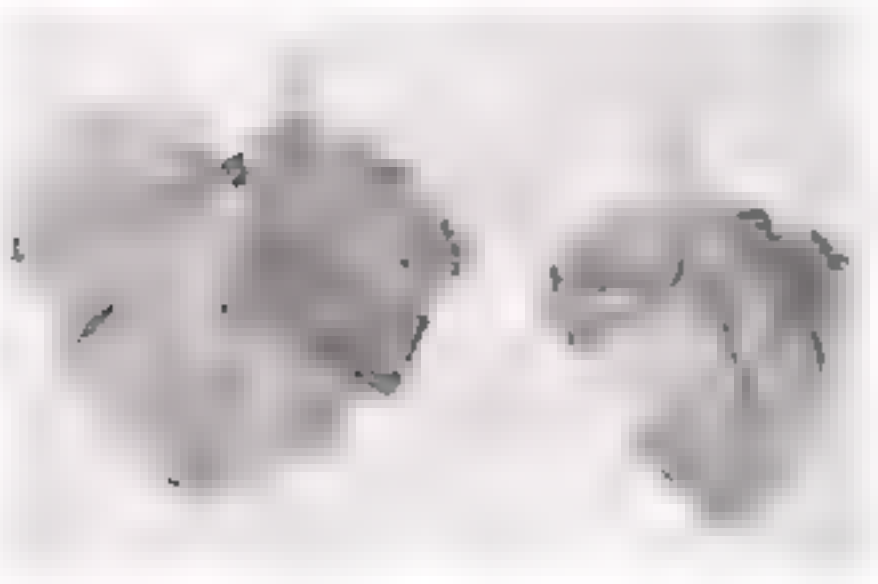
For slight faults and scratches on the cabinet, you can use a special scratch remover and polishing liquid. This usually is made up into a convenient applicator with a felt brush at one end. Touch the injured spot with the brush and the mark disappears.

Synthetic materials now on the market make French polishing a simple matter. A small additional amount of the liquid is placed on a pad already saturated with the French polish and rubbed over the surface of the cabinet with a circular motion until a high gloss is obtained. Fine steel wool, lightly used, will tone down the gloss.



HOME TESTS EXPLAIN PLANT LIFE

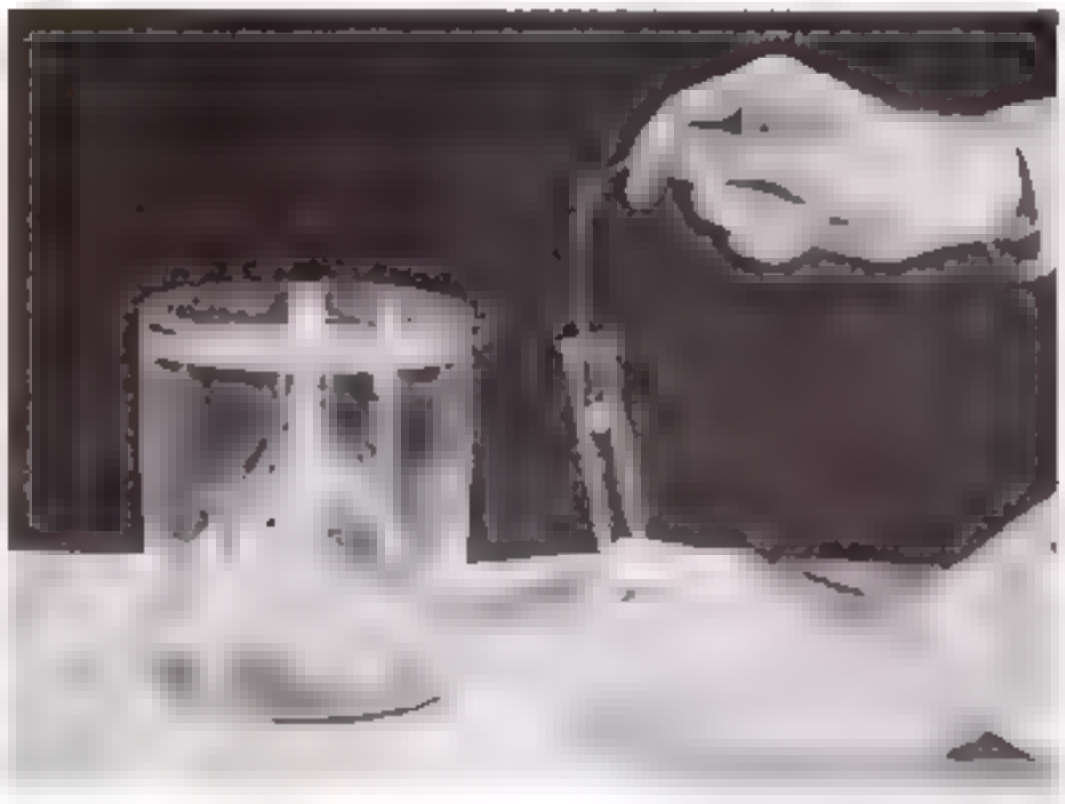
GROWING plants, collectively, constitute the biggest chemical factory in the world. The lives of all animals, man included, depend upon them—for they alone can transform simple chemicals of the atmosphere and the earth into the complex substances that we call food. How they do it remains today a mystery, not yet completely understood by men of science. But enough facts have been discovered to yield significant clues—and, incidentally, entertaining demonstrations like these.



CONCENTRATING MINERALS. Plants get minerals from the soil in extremely dilute solutions—say, one part in 400 parts of water. Where does the excess water go? To find the answer, cover a jar of water with a piece of cardboard, having a hole just large enough to admit the stems of a bunch of freshly picked leaves. Invert a second, empty jar over the leaves, as below. Set the combination in the sunlight. After several hours, the inside of the upper jar will be coated with droplets of water that comes from pores on the under side of the leaves.

SUNLIGHT HELPS MAKE STARCH. With a strip of opaque black paper, cover both upper and under sides of a broad green leaf as at far left, leaving the leaf attached to the plant until bright sunlight has fallen upon it for a whole afternoon. Then soften the leaf for a few minutes in boiling water. Next, boil it in alcohol to remove the chlorophyll or green pigment. Steeped in a solution of iodine, the leaf will now turn dark brown or black where it was exposed to sunshine; the covered part remains colorless. The color-producing effect of iodine, shown at near left, is a positive test for starch.

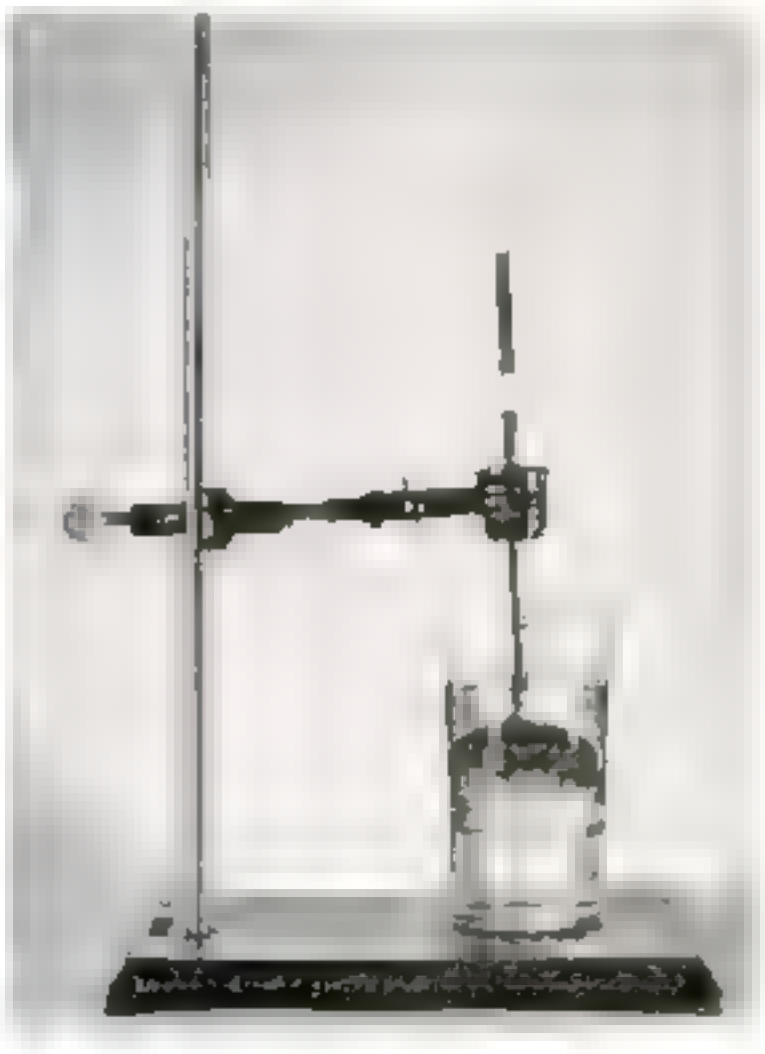
PHOTOSYNTHESIS. Why don't we use up the oxygen in the air? Photosynthesis, main food-building process of plants, offers an answer. In sunlight, green leaves take in carbon dioxide from the atmosphere and turn it into starch and sugar, giving off oxygen in return. Put a water plant in a large jar, beneath an inverted funnel with a test tube over the neck, all being filled with water. Leave the setup in the sun for half a day. Part of the water in the test tube will be displaced by gas. Carefully remove the test tube and thrust a glowing splint into it. The wood bursts into flame, showing that the gas is oxygen.



HOW LEAVES BREATHE. In the experiment described at the bottom of the preceding page, you saw that leaves "inhaled" carbon dioxide, and "exhaled" oxygen. That happens in sunlight. Now place a small potted plant and a glass of clear limewater under a large jar in a dark place. After a few hours you will find that the limewater has turned milky. This time the leaves have "breathed" much as we do, inhaling oxygen and exhaling carbon dioxide. The limewater serves as a test for the presence of carbon dioxide. So that the gases will not be diluted by leakage, the edge of the jar should be sealed with petroleum jelly during the trial Like many other chemical reactions, that of photosynthesis appears to be reversible under changed conditions.

WHY TILLED SOIL HOLDS MOISTURE. Pack two tall glasses with equal amounts of earth Now loosen the top three inches of soil in one of the glasses, by cutting it up with a knife or stick. Add an equal quantity of water to each glass, and weigh them carefully. Let them stand exposed to the weather for half a day, and weigh them again. Both will have lost weight, from evaporation of water, the loss being much greater for the glass with the unscratched soil. Loosening the top layer of earth breaks the pores through which water normally rises by capillary action, delaying the escape of moisture.

HOW WATER RISES IN PLANTS In a glass of plain water, support an inverted thistle tube whose mouth has been tightly covered with nonwaterproof film. The bulb and part of the neck should contain strong salt water, colored with ink. In half an hour, the colored water will rise in the tube. Likewise water or weak solutions enter plant membranes containing denser solutions



How to Put on a Chemical

A white cloth and a blank piece of paper are transformed into a waving flag and a flaming motto in a bit of chemical magic that makes a stirring patriotic finale for a scientific program at your home, school, or club

WOULD you like to stage a program of chemical magic at your school assembly, at the church entertainment, or in your own home? Here are some sure-fire stunts around which you can build such a show.

"Dancing moth balls" provide an exhibit which you can stand at one end of your magic table, to mystify the spectators throughout the show. Without apparent cause, these balls repeatedly rise to the top of a liquid in a jar, hesitate there a moment, and drop to the bottom again. The secret is carbon dioxide gas which adheres to their surfaces and buoys them to the top, where it frees itself and permits them to drop again. Fill any tall glass with water and add a little sodium carbonate. Then drop in a few moth balls, and add, without stirring, a little tartaric acid. After the first violent bubbling, gas will continue to be generated invisibly.

A liquid which continually changes color may stand at the other end of the table, in a beaker which sits on a small electric hot plate, and is il luminated from behind. It is made by dissolving a few crystals of cobaltous chloride in denatured alcohol. Because the alcohol absorbs water from the crystals, the solution appears blue. If you now warm the solution a little, and add cold water, drop by drop, until the solution turns pink, it becomes an extremely sensitive indicator of changes in temperature. Warm it, and it becomes blue; cool it, and it changes back to pink. By having an assistant secretly turn on and off the heat in the hot plate, during your show, you can make the spectators imagine they are "seeing things" when the color changes.

Borrow a small handkerchief from a member of your audience. Quickly dip it in a clear solution, wring it a little and, while holding it away from you with a pair of pliers or tongs, light it with a match. The handkerchief blazes fiercely, flames rising a foot in the air. The lender is certain his handkerchief is gone. When the flame

Show

By KENNETH M. SWEZEY

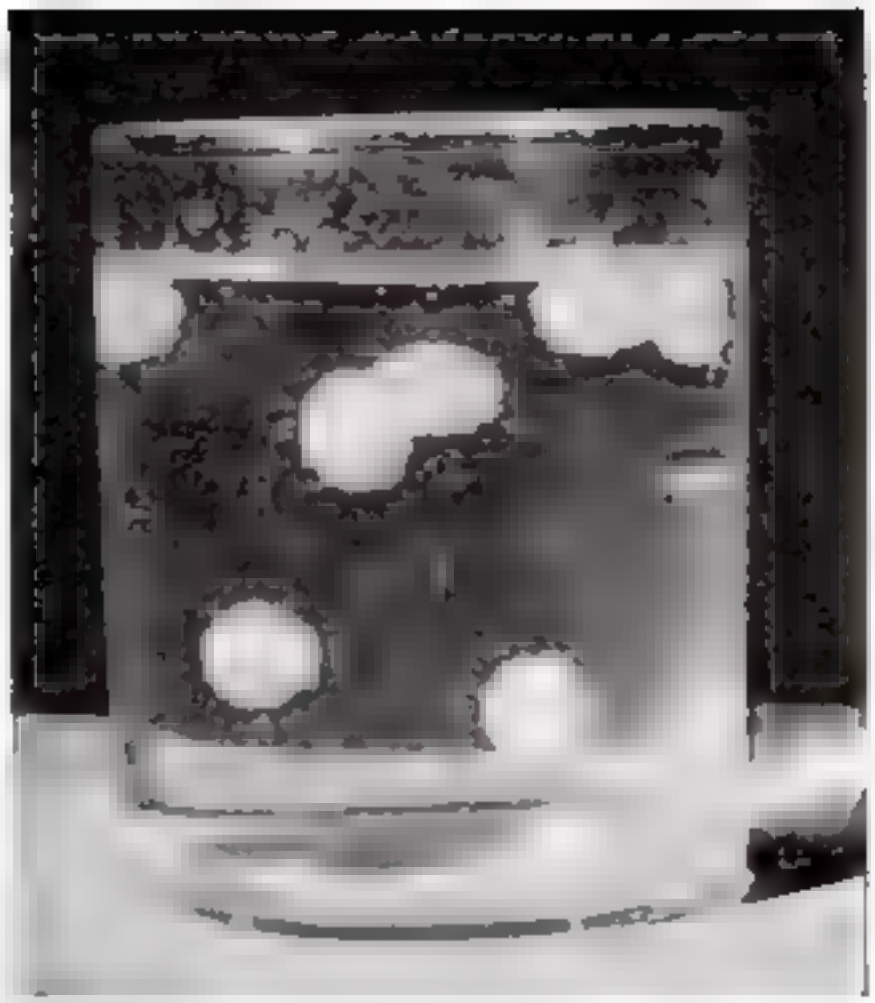
burns out, however, the handkerchief is found to be as good as ever—unburned and even unscorched!

The liquid is merely rubbing alcohol mixed with an equal volume of water. Wet the handkerchief thoroughly with it. When the handkerchief is lit, the alcohol vapor burns, while the water keeps the cloth below burning temperature. If your table is inflammable, burn your cloth over a pan or dish, to catch it if it should drop accidentally.

After handing back the handkerchief to its surprised owner, you pull out another one from your own pocket—this time a blue one. Show everyone its color. Then crumple it in your cupped hands and blow your breath through it a minute. Open your hands again, and the handkerchief is white.

Again, cobaltous chloride is the secret of the color change. Make a weak solution of the crystals in plain water, and soak a small, thin handkerchief in it. If you now dry the handkerchief carefully over heat, its color will be bright blue—the color of the dehydrated crystals. Slight moisture, however, as from your breath, will turn it back to an extremely pale pink, which is practically white. The change may be repeated endlessly.

You can appear to light a candle with a glass rod, by first piling a little mound of a mixture of powdered potassium chlorate and powdered sugar around the wick. Prepare only a very small quantity of this mixture at a time. Do not rub or grind the ingredients together, but mix them gently, as the friction of rubbing might ignite them spontaneously. You now light the candle merely by touching the mixture with a glass rod that has a drop of strong sulphuric acid clinging to its tip. The acid extracts water from the sugar, leaving hot charred carbon which bursts into flame with the oxygen liberated by the potassium chlorate.

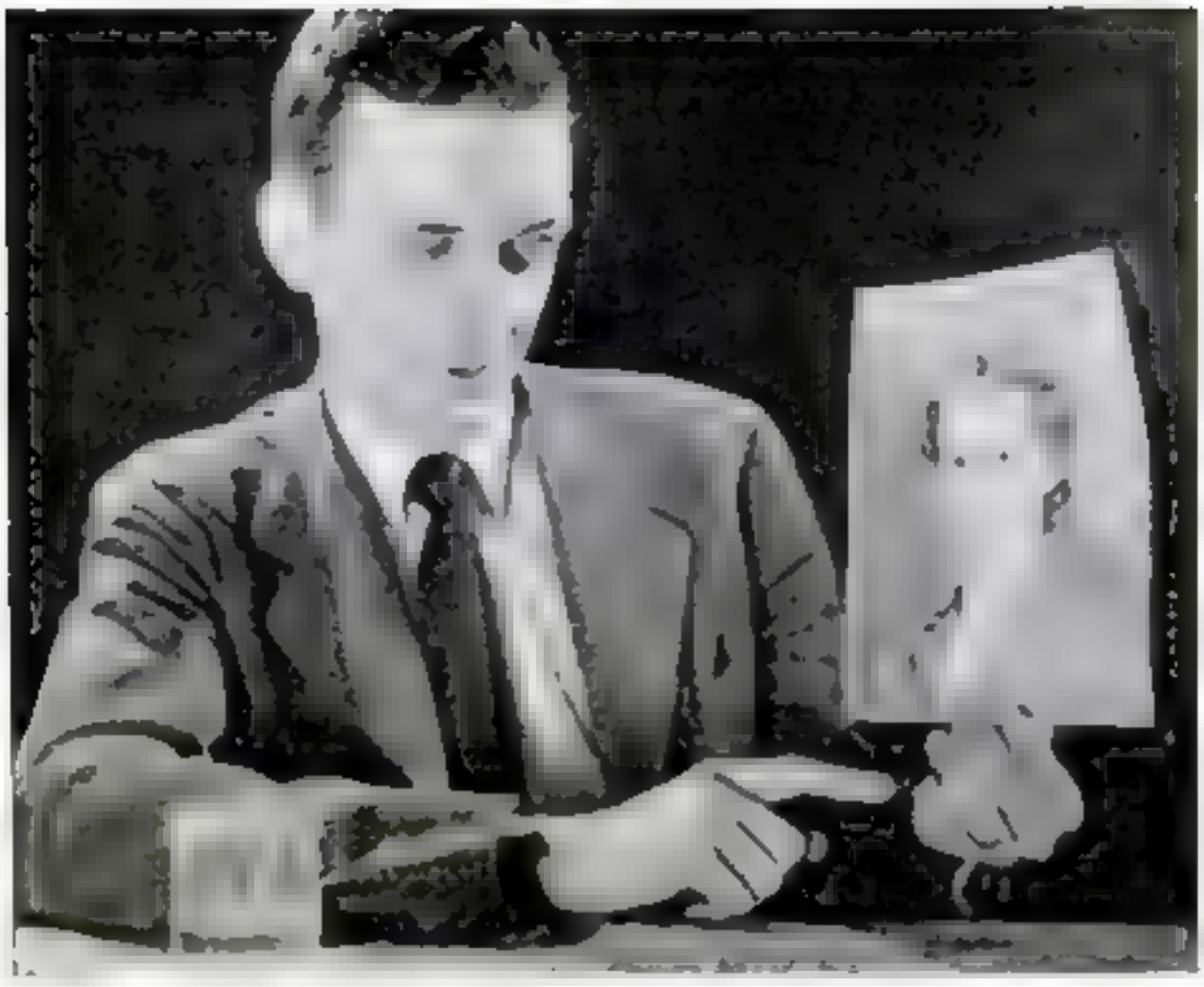


"Dancing moth balls" mysteriously rise to the top of a jar of water, then sink again. Carbon dioxide bubbles generated in the water are the explanation

"Smoke" appears inside two covered glasses. Ammonia in one and hydrochloric acid in the other react to form ammonium chloride

A stunt in which smoke seems to be blown into sealed and covered drinking glasses is puzzling to the layman. The magician produces two empty glasses, places them mouth to mouth, and covers them with a cloth. He then blows smoke from a cigarette, or a piece of burning paper, toward the glasses. A moment later he uncovers the glasses, lifts off the top one, and a cloud of smoke billows forth.

The smoke is, of course, generated inside the glasses. Before the trick, a few



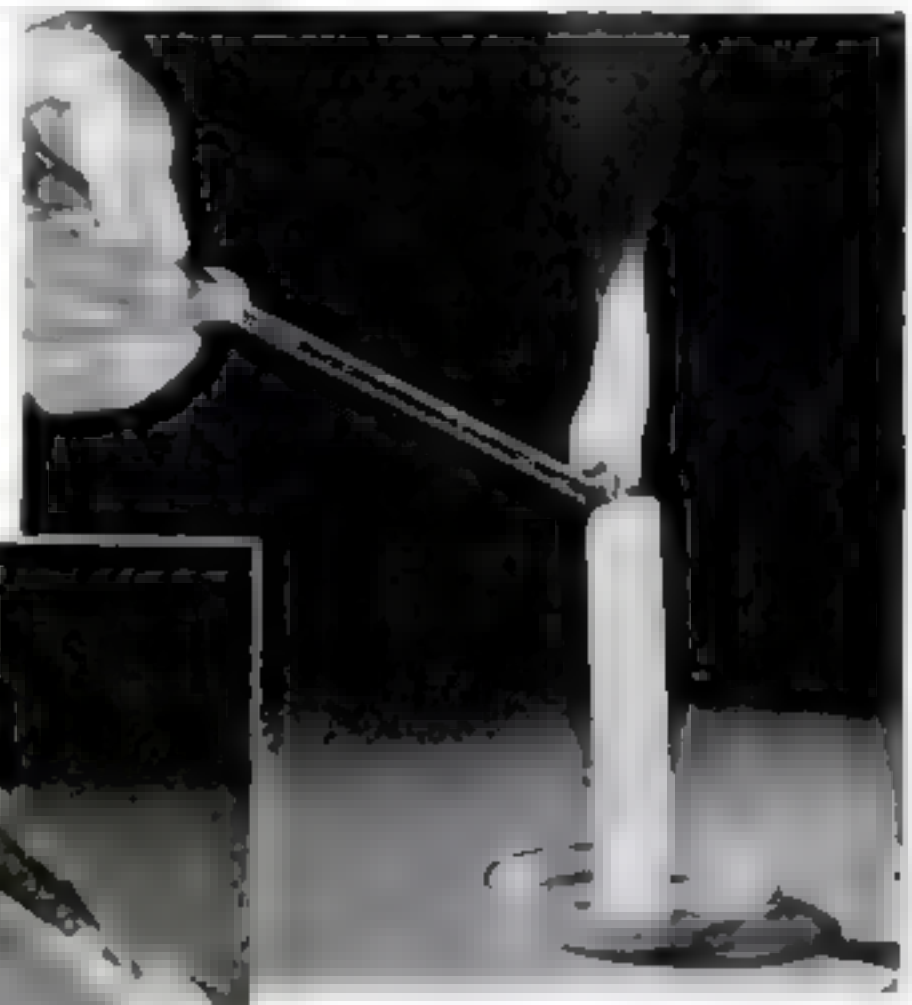
"Making the lady blush." If a good story is told, the cheeks of the girl in the photograph turn crimson! The picture is prepared by painting the cheeks with a phenolphthalein solution. If the finger is moistened with strong ammonia and held near the picture, the cheeks turn red. The color vanishes as the ammonia evaporates

Lighting a candle by touching the wick with a glass rod. Prepare the candle by rubbing into the wick some powdered sugar mixed with powdered potassium chlorate and piling a little more around it, as in the inset below. Light by touching it with a rod to which clings one drop of sulphuric acid

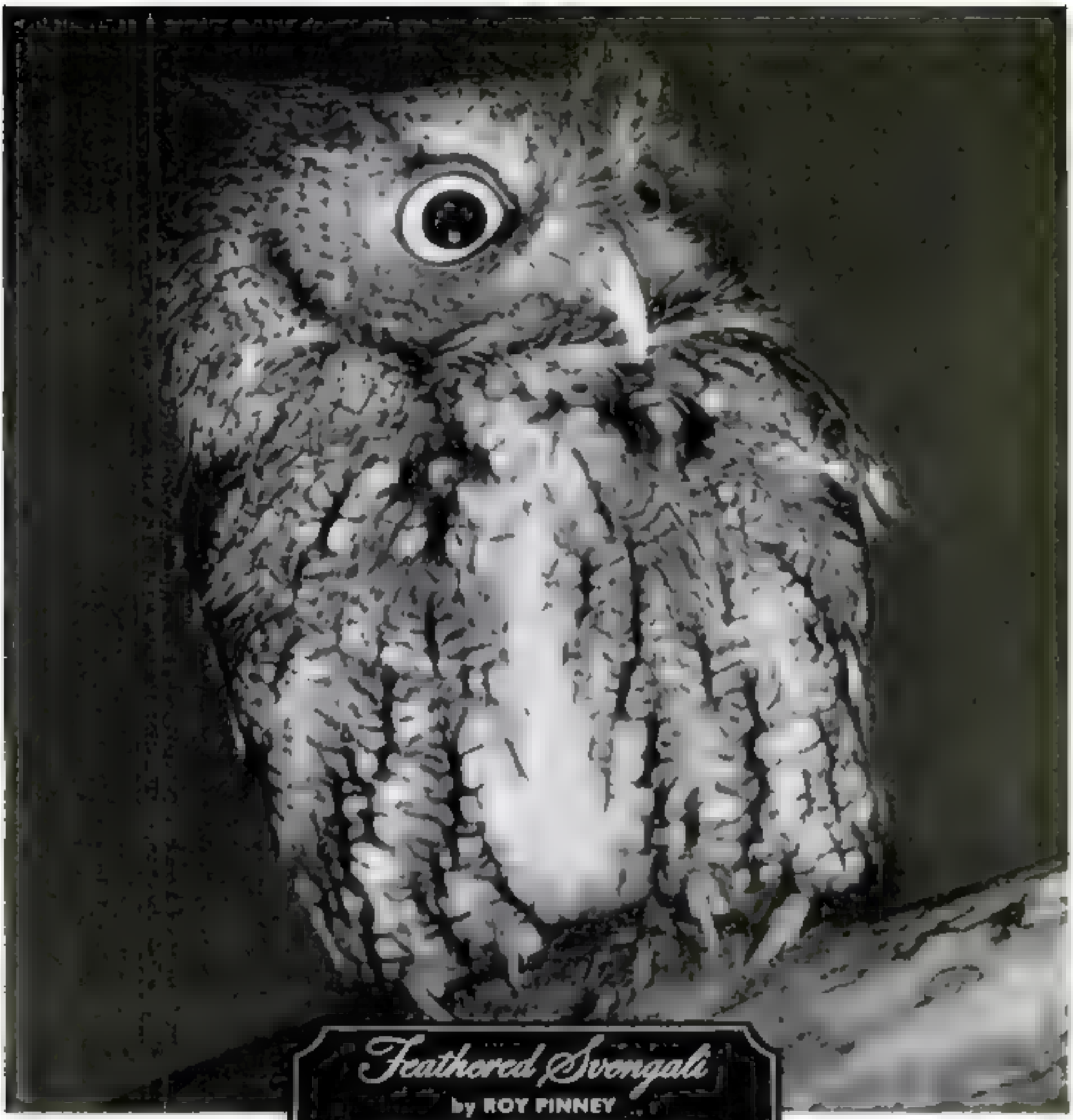
drops of hydrochloric acid are poured into one glass and a few drops of strong ammonia into the other. Rotate each glass to distribute the liquid in a thin film over its inside surface, and pour out any excess. Keep the glasses as far apart as possible before the trick is performed, and finally bring them together quickly, as the reaction is almost instantaneous. The fumes of the two substances form a fine precipitate of ammonium chloride, which resembles white smoke.

To "make the lady blush," obtain a portrait and paint the cheeks carefully with a little phenolphthalein dissolved in alcohol. Just before you attempt the trick, dampen the cheeks again by spraying with a little water from an atomizer. To carry it out, let several members of your audience compete with each other in telling the lady stories. When someone tells a particularly good one, hold a finger that has been dipped in strong ammonia in such a position that the fumes will contact the moistened cheeks. Immediately they turn pink, owing to the reaction of the alkaline ammonia with the phenolphthalein.

For a patriotic finale, you can change a white piece of cloth into an American flag. Outline lightly a flag on a piece of cloth, and fill in the red stripes with a strong solution of potassium thiocyanate, and the blue field with a solution of potassium ferrocyanide. By spraying this cloth from behind with an atomizer filled with a solution of iron chloride you can make the colors come forth vividly.



You can couple this flag appearance with some word outlined in fire. The word should be written on a piece of heavy paper, with a strong solution of potassium nitrate in water, and allowed to dry thoroughly. You may ask the audience to suggest a word, having a stooge call out the one you have already written. When you touch a lighted cigarette or match to the writing, the letters will burn, outlining the word.



Feathered Svengali

by ROY PINNEY
Philadelphia Natural History Society
Film: Kodak Plus-X

KODAK PLUS-X FILM, with which Mr. Pinney made his flash shot, is fully panchromatic. Combines extra speed with unusual fineness of grain. Negatives made under adverse light conditions yield generous enlargements free from disturbing graininess. Has a special antihalation base. Available in rolls and packs.

There is a Kodak Film especially designed for every picture-taking purpose . . . Meet the complete Kodak Film Family at your Kodak dealer's. . . . Eastman Kodak Company, Rochester, N. Y.

The Great Pictures are made on KODAK FILM

The General Drives a Truck

(Continued from page 53)

dream about personal affairs or world problems, letting his attention wander.

These principles for the selection of drivers are among the subjects studied in the two-weeks officers' course at Holabird, but by far the greatest part of the time is spent on the physical maintenance of vehicles and equipment, and 54 hours of work is put in on first-echelon maintenance alone. The echelons, in this usage, are the four divisions into which Army motor care and repairs are organized. They range from first echelon, the maintenance and minor adjustments the driver can provide for his own car, back to fourth echelon, the complete repair and overhaul service available at a fully equipped base shop.

In many ways, first echelon is the most important, because it is the most truly "preventive" maintenance. The procedure for drivers is worked out in full detail, with schedules of required examinations and check-ups before, during, and after operation of the vehicle, as well as more elaborate adjustments and checks at weekly and monthly intervals. Just to give an idea, the "Before Operation" routine starts with an examination of the car in general for leaks of any kind, and ends with the completion of the engine's warm-up period. In between come 14 other check-ups—inside, outside, and under the car. The "After Operation" schedule includes 45 checks "to be sure vehicle is ready to operate again at a moment's notice."

Apparently some drivers always will cut a corner here or there to save themselves a little trouble—and some of them even manage to survive the practice. But that isn't going to be too easy for Army drivers, and it seems reasonably certain that several hundred thousands of Americans eventually will return to private life with the solid lessons of Preventive Maintenance thoroughly drilled into them. And that should have a noticeable effect on the automotive customs and habits of the nation.

The postwar period may even bring the country a standard, unified set of driving arm signals, based on the Army signals illustrated on Page 53.

"Clear signals are essential to safety," an Army slogan points out. "Make your signals clear and definite . . . . no driver is a mind reader. Give them in ample time . . . . and make them last long enough."

That sounds like good sense and *personal* "preventive maintenance" for peacetime as well as for war

...but here is one worry you can avoid

YOU can still use a worn-out, patched-up hose . . . but *not* a broken-down automobile!

That's why king pins, tie rods, drag links, bearings and other vital friction points require the *extra* care, the *superior protection* of stem-to-stern Marfak chassis lubrication every 1,000 miles.

Marfak helps add miles to your car's life because it's super-tough. Applied by chart—not by chance—it resists wear-out, wash-out and squeeze-out.

For your peace of mind, don't say "grease job." Insist on genuine Marfak 40-point Lubrication Service. At Texaco and other good dealers everywhere.

Tune in the TEXACO STAR THEATRE every Sunday night—CBS

You're Welcome at **TEXACO DEALERS**

How About Synthetic Rubber?

(Continued from page 68)

line and other fractions from refinery gases. If necessary, some of the domestic and industrial consumption can be eliminated, which will add to the available supply.

Gasoline refineries also produce large quantities of butane for their own gasoline blending. Here also the yield can be improved in many cases at the cost of some plant additions. Moreover, as the consumption of motor gasoline is brought down by conservation measures, there will be more petroleum for cracking to produce butane directly, less butane will be needed for blending, and the present butane content of motor gasoline can be reduced to afford additional supplies. These considerations must be brought home to the average motorist.

Some of the same materials go into synthetic rubber and 100-octane aviation gasoline. In a sense, therefore, the two are competitive, even though combination units are being built to produce the ingredients of synthetic rubber and the gasoline for our flyers.

Recently, Standard Oil Development Company's technicians worked out a procedure for their latest "fluid catalyst" cracking plants which, in a pilot plant, demonstrated that the process could not only enormously step up the output of materials for buna and butyl rubber, but also increase the output and quality of aviation gasoline.

The principal steps in the production of synthetic rubber may be summarized as follows

1. Accumulation of butanes and other base stocks.
2. Treatment by cracking, hydrogenation, etc., to produce butadiene and other intermediate stocks.
3. Purification.
4. Polymerization to produce rubber.
5. Treatment and fabrication of the raw rubber.

The oil industry, obviously, should be responsible for 1, 2, and 3. Item 5 belongs to the rubber industry. The same would seem to apply to Item 4. But it may be argued that transportation problems would be simplified if, instead of shipping liquid butadiene to the rubber plants in tank cars, under pressure, rubber were polymerized at or near the refineries and shipped to the rubber plants in box cars. Maximum efficiency might even call for locating some of the rubber plants near their source of supply. But obviously complicated readjustments may be involved.

HOME WORKSHOPS Aid War Program in 2 ways

Tucked away in basements and garages from Maine to California are tens of thousands of vitally important machine tools. Operated in home workshops, these tools are bringing happiness and "release" from the speed and strain of modern life to a growing army of home craftsmen.

Today, Uncle Sam is mobilizing this reservoir of tools and this reserve army of hobbyists for the desperate battle of war production. For, vast though America's manufacturing resources are, they must be reinforced by every available bit of man and machine power to speed the arming of our fighting forces.

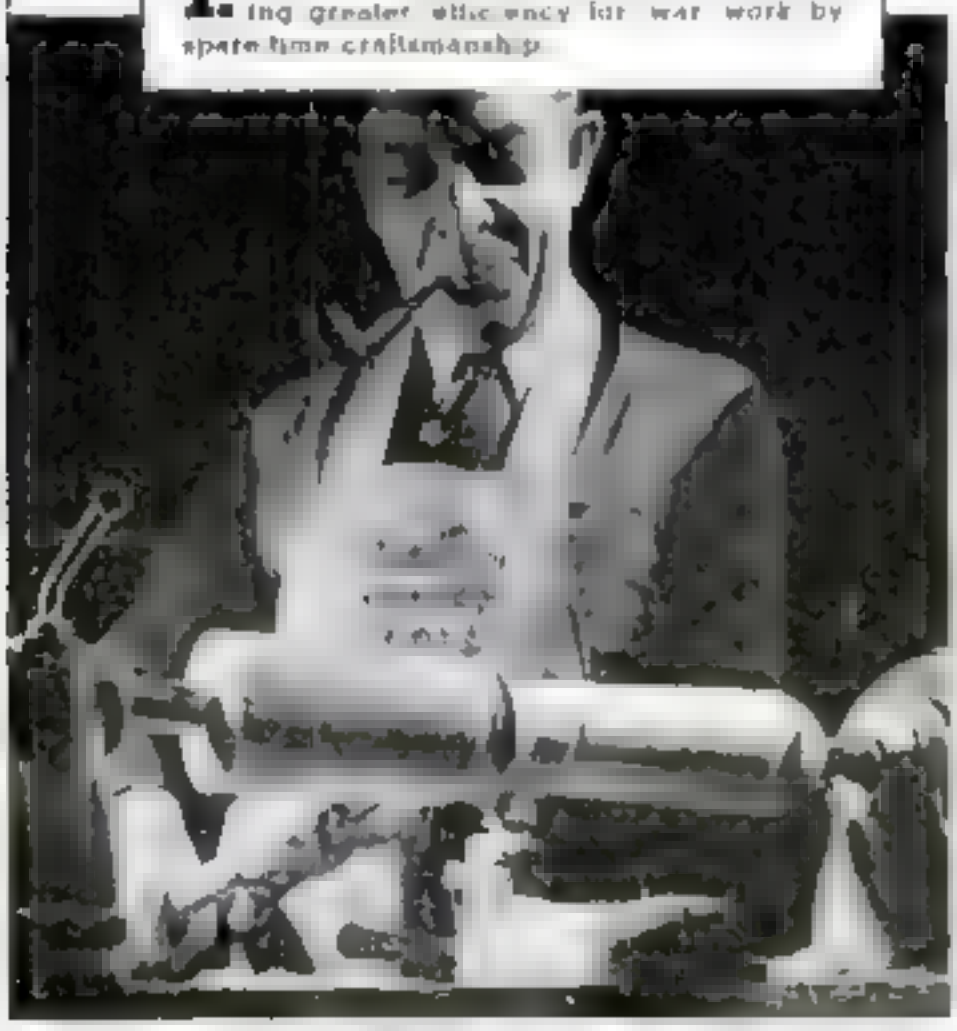
Already hundreds of lathes and saws and drill presses, which once turned out furniture, model planes, ships and novelties are producing parts for guns and planes and shells on war-order sub-contracts.

Now, through the pooling unit of the Division of Contract Distribution of the War Production Board, every machine and every home craftsman in the country is asked to enlist in America's victory production army!

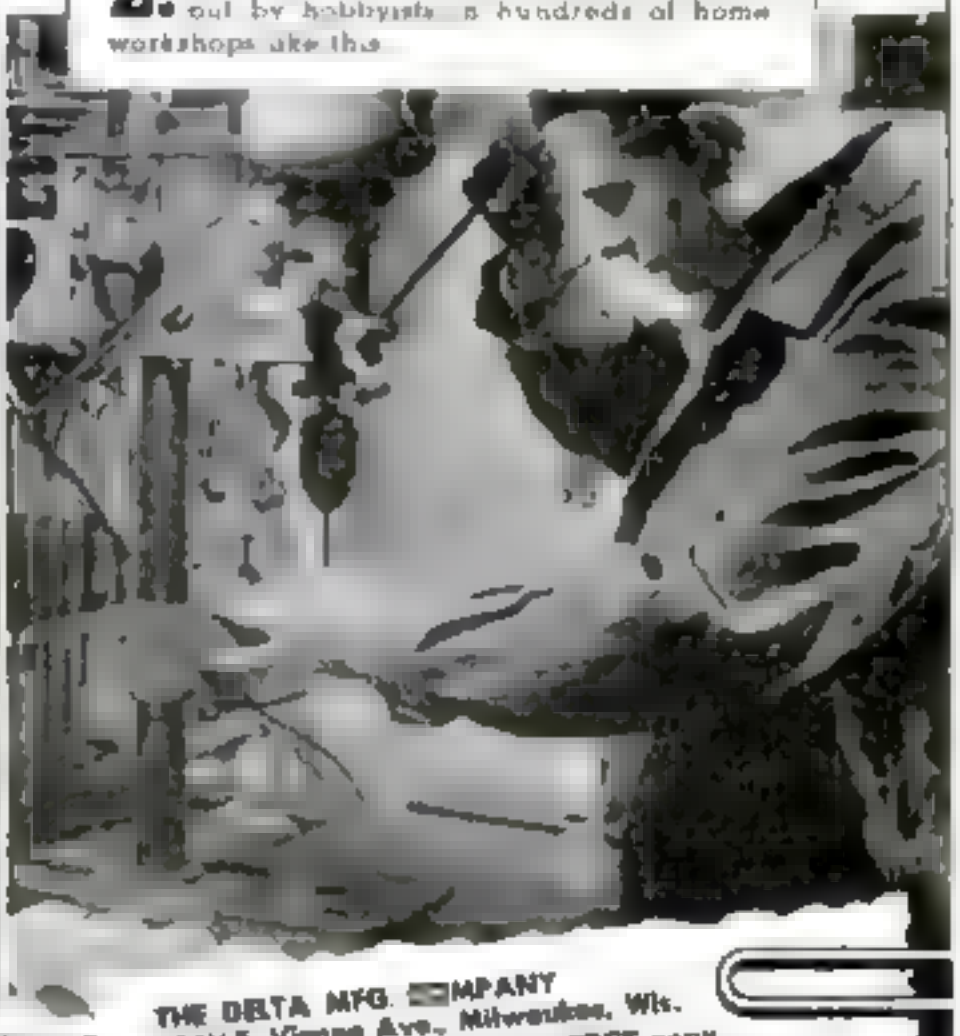
Send for FREE Booklet

If you own a home workshop or are interested in machine handicraft . . . for business or as a hobby . . . find how you can enlist your skill and your machine tools in behalf of your country! Send for "Happiness is in Your Hands." It gives full details of how happiness can be obtained through creative handwork and contains practical suggestions for building up your own home workshop

1. Hundreds of thousands of men are gaining greater efficiency for war work by spare-time craftsmanship



2. Small parts for guns are being turned out by hobbyists in hundreds of home workshops like this



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Gentlemen: Please send me FREE copy of your booklet "Happiness is in Your Hands" telling how to build up a home workshop

Name

Address

City State

Diamond Dies

(Continued from page 103)

exit on the other side of the die. The curve from entrance to exit must be perfectly smooth; if there are "steps" in it they will break the wire being drawn. To avoid "steps," the needle must have a "guide," 1/10,000 of an inch long, that is a straight cylinder; then it must be shaped to drill out the desired bell-mouthed entrance and exit.

The recently perfected drilling machine mentioned previously has a grinder controlled by a micrometer adjustment that makes the proper shaping of the guide and needle automatic. The grinder is a wheel made of diamond dust compounded with metal; it wears away a millionth of an inch in a day's operation, and must be adjusted every four hours. Used in this machine, a needle is good for 20 or 30 sharpenings, and in eight hours of operation over an hour is saved by not having to change needles.

One of the most difficult operations in the making of small diamond dies is the piercing of the back of the stone. The drilling is started from the entrance side and continued two thirds of the way through the diamond. Then it is completed from the other side. A newly developed device, based on optics, made available to American die makers by the British government, makes this work much easier by enabling the operator to center the die with such precision that the axis of the back piercing is certain to be coincident with the axis of the portion already drilled.

After the drilling is completed the interior of the die must be polished to perfect smoothness. This is done by a machine in which the die is held at various angles while its parts are polished by a revolving and oscillating bronze wire.

Polishing completed, the die is sent to the inspection department, where it is examined through a powerful microscope and checked for size by a soft wire being drawn through it and then measured with a micrometer of special design. The die then is mounted, and is ready for service.

The making of a small-size diamond die, American fashion, takes about 20 hours of highly skilled work. Such dies sell for from $25 to $50—the average is $40. Dies ranging from .0019 to .004 inch, which are much easier to make, sell for about $15. Those prices seem very small change when you compare them with the cost of a Flying Fortress or even a medium tank—but diamond dies are one of the little things, the tremendous trifles, which are playing a big part in this war.—ARTHUR GRAHAME.

Gus Figures Out a Gilhickie

(Continued from page 127)

"Sometimes the gasket of the choke cover shrinks or breaks and allows cold air to get in. That slows down the operation of the choke. The only sensible thing to do is to put in a new gasket.

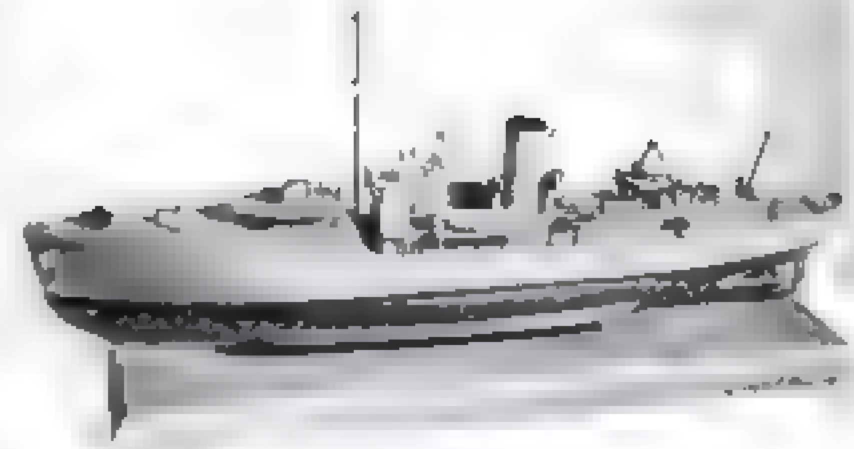
"Sticking choke valves can cause trouble. If a valve sticks open, the result is hard starting. If it sticks closed, or even partly closed, the result usually is hard starting and poor engine performance. Sticking valves usually are caused by a bent shaft or by sloppy valve installation, but sometimes the cause isn't anything more serious than dirt. If the parts are damaged, they should be replaced. Well, Doc, I'll have to be starting for the Park House, or they won't have any dinner left when I get there."

"I'll eat with you," Dr. Marvin said. "My wife is having a day down in the city. Do you know what I'd like to do if I had a couple of spare hours this evening, Gus? I'd like to take one of those automatic chokes apart and see just how it works. They're interesting—what was it that Ez Zacharias called them?"

"Gilhickies," Gus told him, grinning. "A gilhickie is first cousin to a gadget. I like all the new gilhickies and gadgets modern cars have, Doc—figuring them out keeps me interested in automobiles!"

Time a Factor in Drunkenness, Laboratory Tests Reveal

DRUNKENNESS does not depend altogether on what you drank, but also on when you drank it, according to tests conducted by Drs. Henry Newman and Mason Abramson, of the Stanford University Medical School. Their results indicate that standard police tests, based on the concentration of alcohol in the system, may not be accurate criteria of drunken driving. Two men were tested by requiring them to aim at a moving target while under the influence of alcohol. Accuracy dropped rapidly after the first drink, but gradually returned to normal despite small doses which kept the alcohol concentration in their systems constant. The conclusion is that the presence of alcohol in the system over a period of several hours effects a change in the response of the nervous system to alcohol with the result that concentrations which originally produced drunkenness no longer are capable of showing this effect.



New Construction Kit Builds Modern Canadian Corvette

A DEVELOPMENT of modern sea warfare, 160' long corvettes are being built by England and Canada on a mass production basis to do the work of destroyers in guarding convoys and fighting submarines. Each is armed with a 4" gun forward and two depth-charge guns and a pom-pom (anti-aircraft gun) aft. The large bilge keels are designed to counteract rolling in heavy seas.

Our construction kit No. 16S for building the 20" Canadian corvette model above includes all hull and spar material, full-size drawings, and 31 *finished* fittings (bell, bitts, chocks, ventilators, anchors, propellers, gun, and pom-pom). It is shipped postpaid for $6.75†.

For an illustrated list of our other kits, send a stamped, self-addressed envelope.

6M	Fishing schooner WE'RE HERE, 9½" long	$ .60
8M.	Racing ketch, planked hull, 18" long overall, 2¼" beam, sails included	1 25
9M.	U. S. Destroyer, Mayo class, 12¾" long, (finished capstan and anchors)	1 00
E.	Battleship U.S.S. TEXAS, 3' long, scale 1/16" equals 1'	7 95*
V.	Clipper SOVEREIGN OF THE SEAS, 20¼" hull, 28" overall. Kit includes anchors, flags, bell, capstan, brass ladder	5.30†
2S.	Fishing schooner BLUENOSE, 17¼" hull, scale, ⅛" equals 1'. Kit includes anchors, wheel, bell, flags, mast rings	5 30†

Note: If you live west of the Mississippi River, add ■ cents to price marked with an asterisk (*) and 25 cents to prices marked with a dagger (†)

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Our Tested Shop Blueprints Guide the Craftsman

WITH the country's production machinery geared to vital war requirements, the home craftaman may well turn his skill and spare time to advantage by building things needed in the home, on the farm, or in the vacation camp. There's fun and satisfaction in turning out a handsome table or bookcase, a serviceable boat, durable porch and lawn furniture, or other worth-while projects.

Good blueprints insure sound design, save materials, and eliminate guesswork, thus returning more than their modest cost on almost any job. A partial list of our blueprints follows. For a complete list, send a large, self-addressed, stamped envelope. An illustrated leaflet of boat plans will be included upon request.

MISCELLANEOUS

Auto Ski Rack, Turned Flower Basket, Ornamental Miniature Wheelbarrow, 414A	$ .25
Folding Wall Brackets (turned), Treble Clef Bud Vase (metal or plastic), Vacuum Cleaner Attachment Rack, 408A	.25
Hostess Tray, Modern Book Ends, Machinist's Hammer, Lathe Dog, 412A	.25
Workbench for Home Shop, 24" by 58" by 34¾" high, 405	.25

FURNITURE

Combination Bench and Tilt-Top Table, (no turning), 11	.25
Early American Style End Table, 361A	.25
Four-Leaf Card or Occasional Table, 239A	.25
Modernistic Folding Screens, 4 designs that require no turning, 91	.25
Sewing Cabinet of 1812, 178A	.50
Smoking Stand, Modern, 238A	.25
Tavern Table and Scroll Mirror, 103	.25
Tea Wagon (removable tray and drop leaves) 20" by 30" top (turning), 13	.25
Tile-Top Tables (wood and metal), 349A	.25

BOATS

Camper's Utility Boat, 11' 2" long, canvas-covered, for outboard motor or rowing, 281 R	.50
Cruising Sailboat, 19' long, weighs 700 lb., Marconi sloop rig, can be used with 1 to 4 h.p. inboard or outboard motor, 400-401-402-403-404-R	2.00
Sectional Rowboat, 9' 6" long, two sections, weighs 60 lb., all wood construction, can be used with small outboard motor, 340-341-R	.75
Utility Rowboat, 13' long; can also be sailed or driven by outboard motor, 324 R	.50

LEAFLETS AND BOOKLETS

Garden Fireplaces, Furniture, and Pools	.35
Hints on Cutting and Drilling Glass	.15
Home Workshop Index for 1941	.10
How to Build and Operate an Inexpensive Arc Welder and Spot Welder	.50

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Send me the blueprint, or blueprints, numbered as follows ....

I am inclosing .... dollars .... cents

Name ....

Street ....

City and State ....

(Please print your name and address very clearly)

Lilliputian Models Win Prizes in Our Miniature Contest

THERE was nothing small about the skill turned up in our recent miniature contest. Many of the tiny entries had such remarkable detail that, except for their size, they might have been taken for their prototypes. Tools predominated—exquisitely made pliers, wrenches, micrometers, calipers, planes, and the like were submitted. On the unusual side were such entries as a ½" long dentist's forceps, a rotary rock bit, and a tiny bear trap.

A few of the projects will be described and illustrated in an early issue of POPULAR SCIENCE MONTHLY. The judges increased the number of five-dollar prizes from two, as originally announced, to three. Following is the list of winners and those receiving honorable mention:

$15 award, Victor Roming, Carmel, N. Y.
$5 " Frank T. Freeman, Ada, Okla.
$5 " John H. Martin, Houston, Tex.
$5 " Wassil Olevia, Palmerton, Pa.

HONORABLE MENTION: W. H. Barden, Jr., Herald Bartels, Dr. W. G. Bridge, George Brillinger, A. Gilbert Buckwalter, Stewart Cage, Jim Carver, J. W. Connors, Elwood Dandridge, M. A. David, Jack Dench, G. L. W. Draper, P. L. Fluker, Stanton M. Francis, Walter F. Getzlaff, H. Gleason, Emmanuel B. Haffner, Glenn W. Harding, Bruce Haverstick, Richard E. House, J. H. Hunter, James E. Janson, Miss Dorothea E. Kaucher, Otto Kinzel, Melvin Koch, C. T. Lyon, William Mack, R. L. McBrien, Frank McCarty, E. P. Michel, J. E. Minner, James E. Morse, Norbert R. Mumbach, Emory C. Nycum, John Patterson, A. F. Perry, Richard H. Plantz, A. H. Pressnall, C. A. Preston, Joffre Raymond, James R. Ross, Mrs. Florence Sanquist, Stanley A. Schaffer, H. A. Schreffler, Dewey Sorenson, Marshall Travis, Fred E. Uthoff, W. J. Ward, William Walker.

Photographers Asked to List Foreign Travel Pictures

IF YOU have taken either motion pictures or still photographs anywhere *outside* the United States, you can do the Government a service by supplying a list of these pictures. A form for this purpose may be obtained by writing to the Amateur Cinema League, 420 Lexington Avenue, New York, N. Y. The League has undertaken to locate for the Government as many sources as possible for motion-picture footage, still photographs, and transparencies of areas outside the United States. You are not asked to surrender any of your pictures, but merely to promise that, if requested, you will give the Government permission to make, without cost to you, duplicates of any footage or still photographs. The quality of the pictures is unimportant; the Government is interested only in the subject matter.

Antitarnishing Cloth Keeps Silverware Gleaming

CHEMICALLY treated cloths that can be wrapped about silverware, silver musical instruments, jewelry, and other tarnishable articles when they are not in use can readily be purchased, but questions are sometimes received as to how they may be prepared at home. The flannel or other cloth is soaked in a solution of ¼ lb. cadmium-acetate crystals dissolved in ½ gal. water, then wrung out and allowed to dry.

The silverware or other objects should first be wrapped in their ordinary untreated protective cloth holders or containers, or in tissue paper, and the special cloth wrapped around the outside. This is important because the chemical is poisonous. If it is allowed to come in contact with the silverware, be sure to wash the latter before using it. The cadmium acetate impregnated in the cloth combines with the hydrogen sulphide of the air and, because of its filtering action, keeps the metal bright. It is a good idea to wrap another ordinary cloth around the whole bundle as the treated cloth will then last longer.

A more cumbersome method of obtaining the same result is to use a fairly large quantity of camphor, dichlorbenzene, or naphthalene (moth balls or flakes). These will prevent entry of air if the articles are wrapped with them in a tightly closed box.

Coloring Drab-Looking Stucco

ANYONE looking for a simple and inexpensive method of coloring drab-looking old stucco might try the following method. The writer used it on a house in Syracuse, N. Y., ten years ago, and the color is as clear and uniform as when first put on. Masons have asked on several occasions how to duplicate the results. All that was used was a dry mineral color, a little plasterer's lime, and water, mixed in the proportions of about 1 lb. color, ¼ lb. lime, and 2 gal. water. This was well stirred and applied like thin paint with a whitewash brush to the thoroughly dry stucco.—D. H.

Steel Wool Erases Price Marks

IN A LARGE supermarket where every article has to be marked with the price, we tried various methods of removing the marks when it was necessary to make changes. We soon found that the most convenient eraser was a piece of steel wool. It can be used even to remove black drawing ink from paper labels, cans, and cardboard packages.—VERNE F. BUDBILL.

Winged Attackers

(Continued from page 63)

themselves together into shock troops of a tougher, more dangerous type than have ever before been imagined.

None of the foregoing is to be taken as disparagement of the parachutists. In any large-scale airborne operation, they will be right there, landing under the protecting fire of the glider troops and in some instances breaking the ice themselves. The transport planes slant in, coming low in a shallow dive with the men jumping in rapid succession, so that the last man jumping, from a height of less than 500 feet, may hit the ground first. They land armed and fighting, too, though their weapons must be lighter; and their pockets are loaded with grenades and TNT.

But the parachute trooper has many other special uses too. Once he has learned to jump, and been drilled in infantry tactics, his training has only begun. He is a fighter of the more individualistic sort, a kind of inland commando, a hellion to make general trouble behind enemy lines. Surprise, sneak missions are his specialty. He must know how to blow a bridge, steal a locomotive, drive any car or tank.

Cargo planes have many of the advantages of gliders, and can carry even heavier equipment, but they need a bigger place to land. Once a stretch of plain or tilled ground has been seized by the advance forces, the air-landed troops can come in. These planes have low stalling speeds, and their tricycle landing gear makes them pretty stable even on fairly rough ground. If they crash, they are simply hauled aside to make room for more.

Once the operation has expanded to the point where it encompasses an airport and can land troops under protection, of course, everything becomes much more simple, though still supplies would have to be dropped by parachute to avoid traffic congestion. The job then becomes one of air transport, such as that which reinforced and supplied Rommel's army in Libya and maintained Nazi resistance last winter on surrounded outposts of the Russian front.

All three types of airborne troops would work together in any major operation. Their co-ordination, among themselves, with their bases, and with their bomber and fighter support overhead, presents problems of staff work and communications which would have been an impossible nightmare to the commanding officer of a few years ago.

To get some notion of this, let us consider a simple problem of a sort which is doubt-

less confronting the airborne commands this summer

Modern battle lines, such as have developed on the Russian front, are many miles deep, with a maze of slit trenches and barbed wire entanglements covering the entire countryside, and strong points so placed that they command almost every inch of strategic ground with crossfire.

Our problem is to find a point toward the rear which can be weakened, neutralized, or taken over, to prepare the way for an assault of mechanized troops cutting through from the front. The first step is several days of heavy bombing over extensive territory. Every time a gun emplacement reveals itself by antiaircraft fire, the observers mark down its precise location. Thus the strong points are revealed.

Several places are to be attacked at once, for some of the attacks will fail. The most successful of them will get support, men, ammunition, guns, and finally food to eke out their scant emergency rations. All these places and many more are bombed, keeping the enemy guessing

Every air field in range is in full use, roaring with traffic. The gliders and jumping planes for the first wave are scattered at a dozen different places; from one field it would take hours just to get the armada in the air.

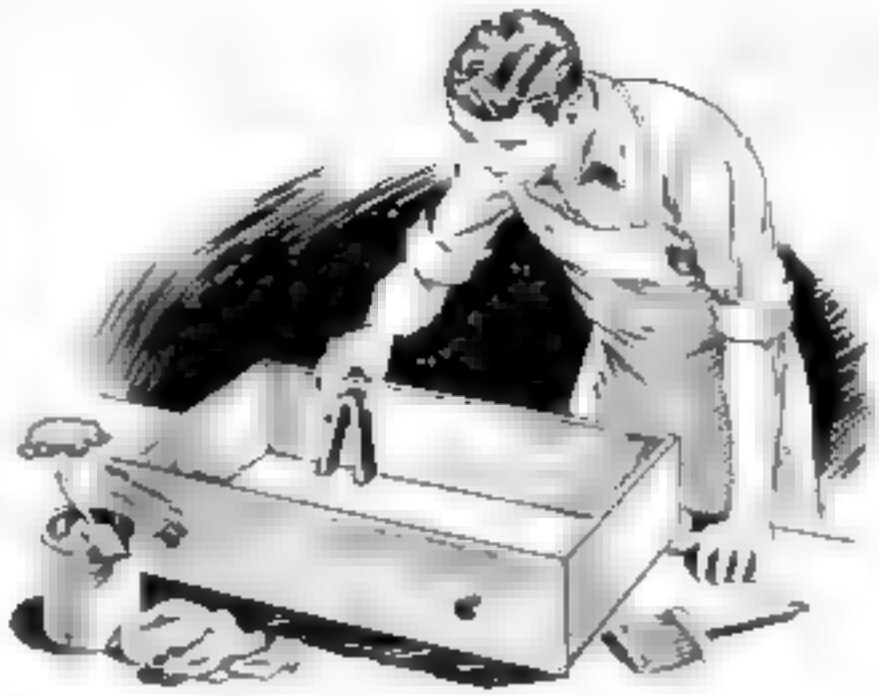
As the gliders slant down, at 100 miles an hour, the final wave of bombers roars in from the rear, blanketing their landing point with a terrific scattering of explosive. While the dust and debris are still flying, and the defenders are ducked down in their foxholes, the gliders land.

Up to this point everything is on schedule, all according to plan in the utmost detail, a tremendous job of staff work and preparation. But after the first waves of gliders and parachutes land, the rest is extemporaneous, based on what is seen by the air observers overhead.

At one point the attack is being repulsed. Forget it. Over there the glider troops are succeeding moderately well, holding their ground. But here in a third place they are really having success. That's the place for reinforcements. Pour in more parachutists and the cargo planes!

Back at the command post all strength is being poured into the soft point that has developed, making it grow bigger and bigger, a cancer in the enemy's back, weakening him for a penetration of tanks.

Bear in mind this is a simple operation. As for an airborne invasion of England or the Caucasus, or of Europe—that would be really complex. It would be fantastic. But so was everything in this war, just before it happened.

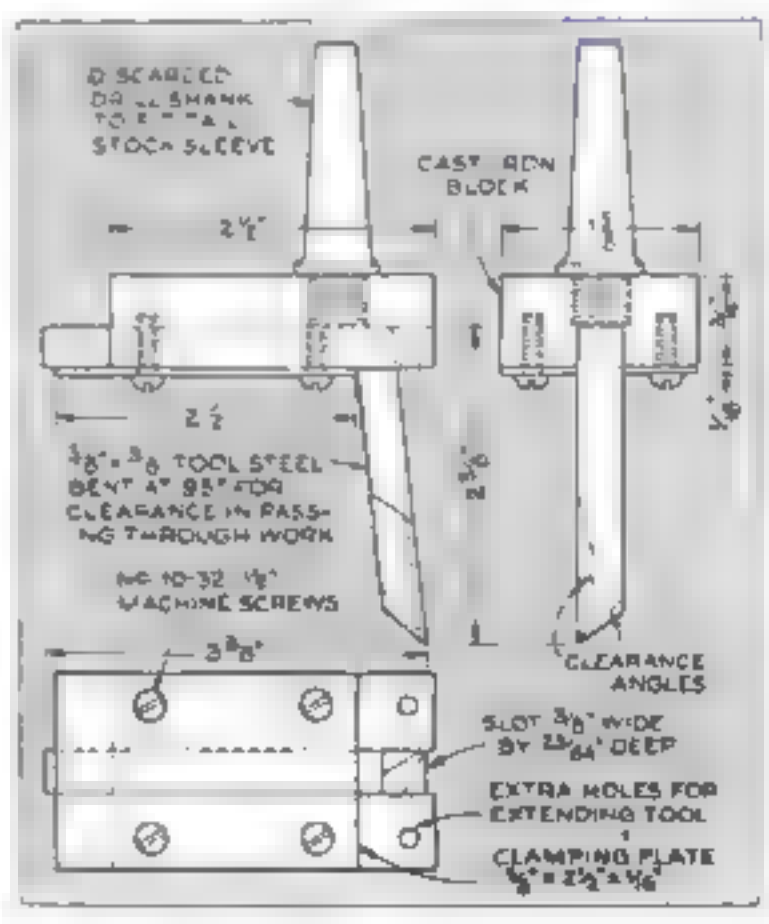


Magnet Picks Up Steel Wool Left on Finished Surfaces

WHEN steel wool is used to rub down coats of shellac or other finishing materials, it is almost a toothbrush-and-tweezer job to remove all the small, broken particles from the corners, moldings, or turnings. After brushing out all you can, merely run a strong magnet over the entire surface. You'll be surprised at the number of bits of steel wool you can pick up which otherwise would have become embedded in the finish.

Lathe Tailstock Tool Bores Holes in Wooden Blanks

HAVING to bore a large number of accurate 2" diameter holes 1" deep in 4" by 4" wooden blanks, I made the tool shown. The blanks are secured *(Continued on page 218)*



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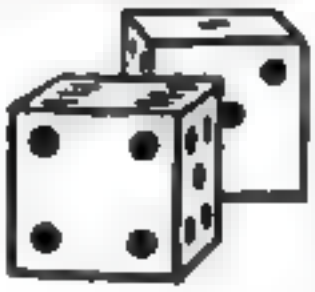

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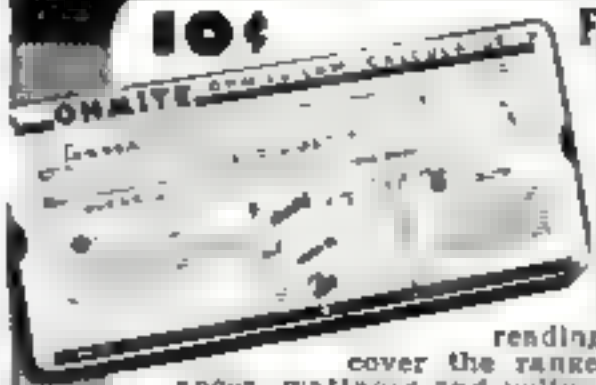

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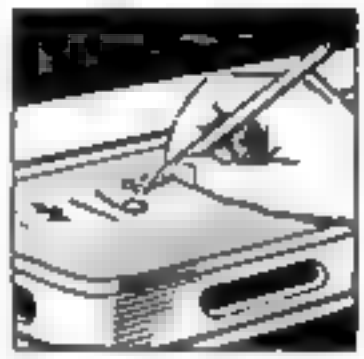
to a buffer or waste piece of wood, which is screwed to the faceplate of the lathe, and the desired hole roughed out by hand to within about 1/16" of actual size. The special cutter is then brought up and fed through the blank with the handwheel of the tailstock. Once the cutter is adjusted for correct diameter, any number of blanks can be bored out in exact duplicate of the original.—FRED STRICKLAND.

Marking Prices or Numbers on Cast-Iron Articles

PRICE marks or stock numbers may be marked temporarily on cast-iron or other metal articles with an ordinary lead pencil if a background of white is first applied with a stick of soft chalk.



Restoring the Body of an Old Rug

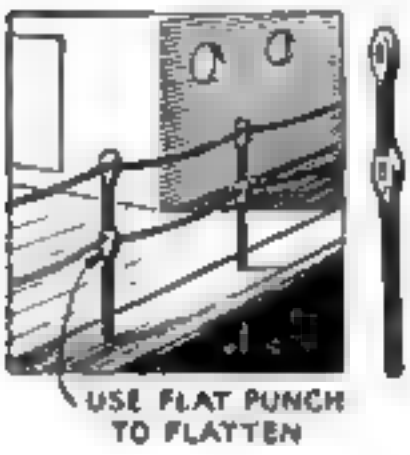
WHEN an old rug loses its body and becomes limp, turn it over and give the bottom a good rubbing of casein glue, mixed rather thin. Allow it to dry for twenty-four hours.

Holes Punched in Monel Metal to Make Drilling Easier

MONEL metal is so tough that heat sufficient to burn the end of a drill bit is generated when ordinary metal-drilling methods are used. When you have to drill the sheet metal, punch a small hole through it first, and then use the drill bit to enlarge the hole to size. Use a slow drill speed and feed. Lard oil can be used as a lubricant.—W. B.

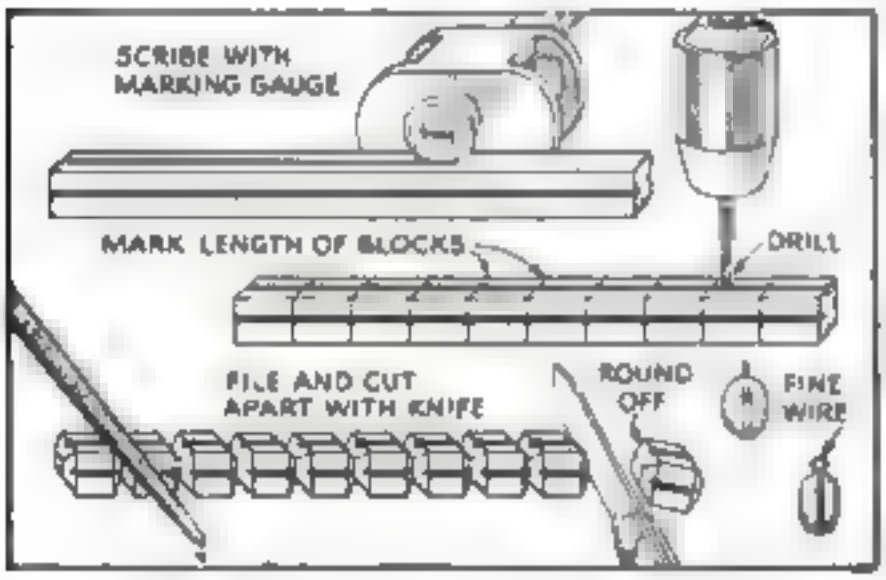
Ship-Model Rail Stanchions Easily Formed of Wire

STANCHIONS for ship models can be made from stovepipe or soft iron wire. Cut the pieces to length, allowing enough extra for inserting in the deck. One end of each piece is then flattened in a vise; a hole is punched through with a needle point, and it is enlarged with a drill to the desired size. If double stanchions are required, the second flat point can be made with a flat punch or a nail set.—R. L. H.



Model Pulley Blocks Shaped Quickly by Strip Method

PULLEY blocks of any size for ship models can easily be made in quantity by the method illustrated. Use hardwood such as rock maple or birch. Scribe all four sides of a strip deeply with a marking gauge, being careful not to split the wood. Mark off, drill, and cut apart individual blocks; then round off and shape the edges with a sharp knife. Finish each block perfectly smooth on a sanding block.—PAUL H. SMITH.



Catgut Ukelele String Makes Durable Necklace Cord

A FIVE-CENT ukelele E string of the catgut type makes an excellent cord for restringing a bead or pearl necklace. Thread the parts on the dry catgut, then soak the ends of the latter for two hours between the folds of a damp cloth before tying the knots at the clasp ends.—K. F. KEITH.

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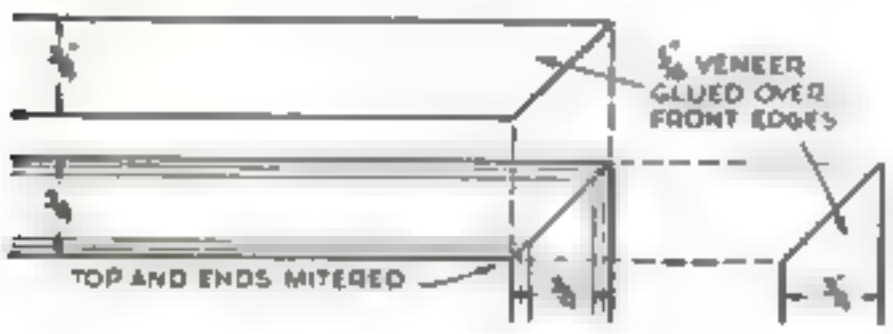
Attractive Cabinet Conceals Old-Style Sewing Machine



OUR sewing machine, although in excellent condition, is of the old-fashioned treadle type, so I made a modern plywood cabinet into which it could be rolled when not in use. The top and the ends are ¾" Philippine mahogany plywood, but walnut, gum, or any wood could be used to match other furniture. The doors are of the same wood ⅜" thick. The back is ¼" fir plywood. Exact measurements depend upon the machine. In this case the cabinet is 40" long, 21" wide, and 32" high.

Cutting the mitered joints on the top and the ends is a ticklish job if you have no power saw, but a planing mill will do the job at trifling cost. The top is then glued to the ends and held with clamps until dry Two steel angle braces screwed on the inside of each joint will strengthen the job. Cut the fir plywood back to fit inside, and glue small blocks of soft wood ¼" inside the back edges of the top and ends. The back is nailed to these blocks.

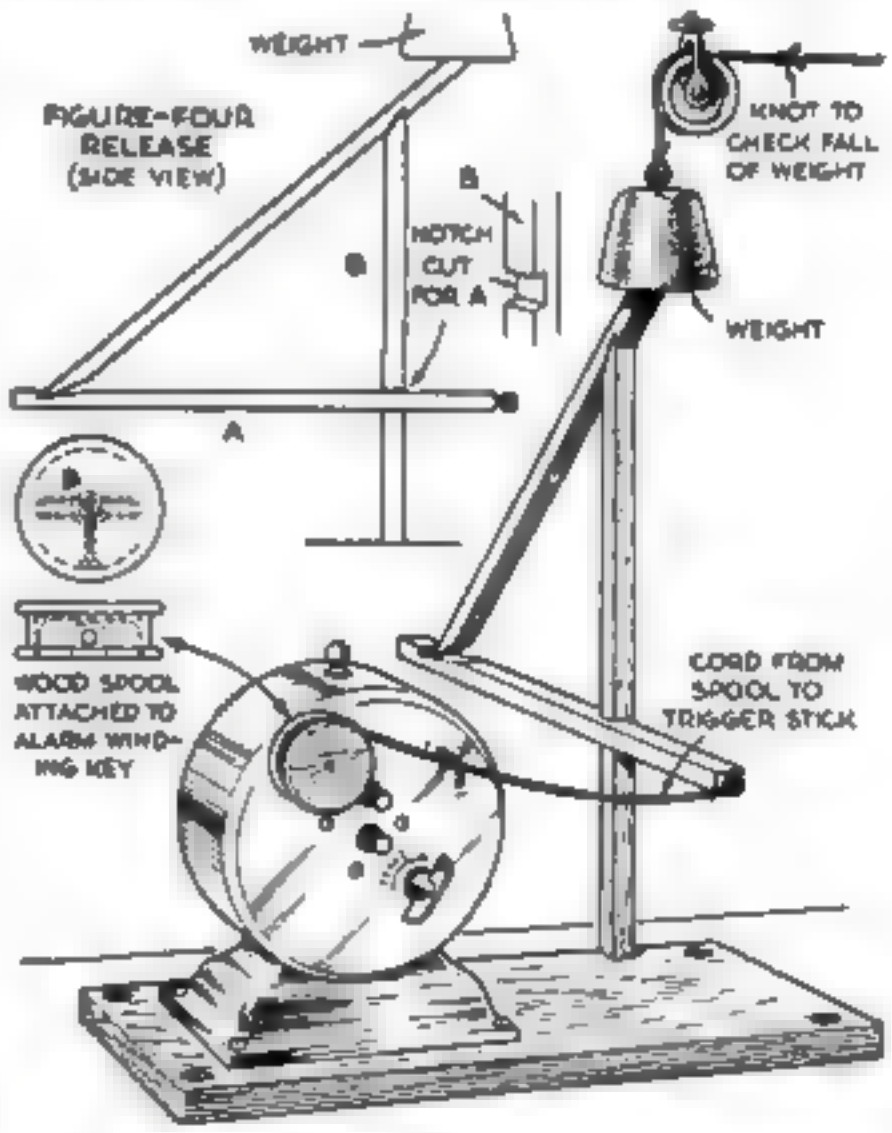
The next step is to conceal the front edges of the top and ends. If you cannot easily obtain mahogany veneer, you can do as I did. From narrow pieces I had left after the top and ends were cut, I ripped off strips a little wider than ¾" and soaked them in hot water. Then I carefully stripped off the mahogany face wood and dried it thoroughly. These thin strips are fitted on the front edges of the cabinet and glued, then sanded down to exact size.

The doors should fit closely at the top and sides and come within ½" of the floor at the bottom. When closed, they are held by small bullet-type catches set in the underside of the top. A small block glued just behind the catches will prevent the doors swinging too far inward. Two knobs complete the necessary hardware.

Any desired finish may be used; I applied white shellac and wax.—B. P. SMITH.

Clock and Figure-Four Trap Form Simple Time Release

TO PULL electric switches, open kennel slides, feed stock at a given time, or set in motion other devices, a time release can be arranged by the use of an old-fashioned alarm clock connected to a trapper's "figure four" as shown. When the alarm goes off, the spool on the alarm-winding key pulls the string and drags stick *A* out of the notch in *B*, whereupon the figure four collapses and releases the weight.—W.H.F.



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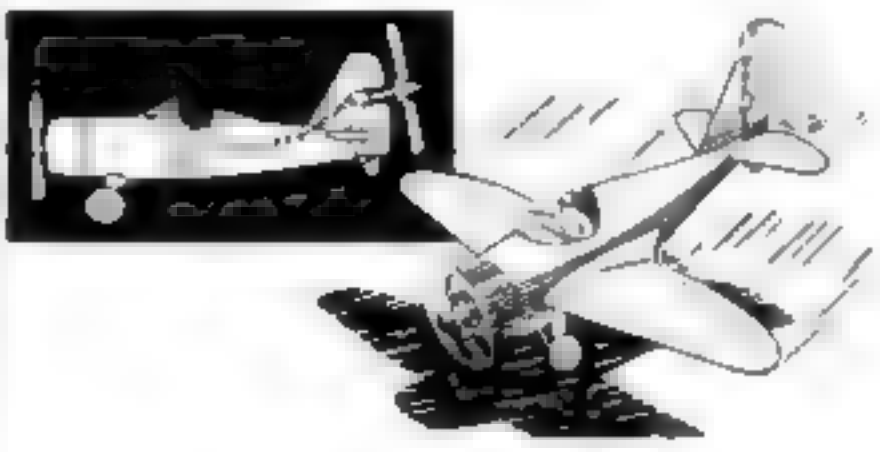
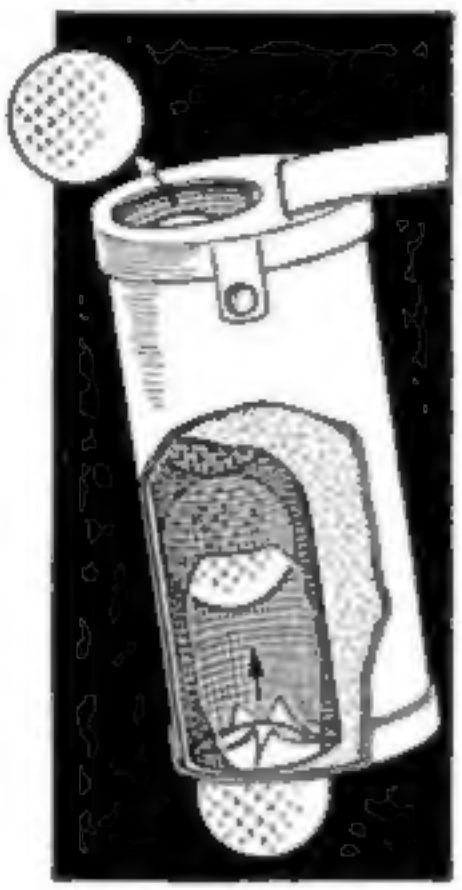
With the Inventors

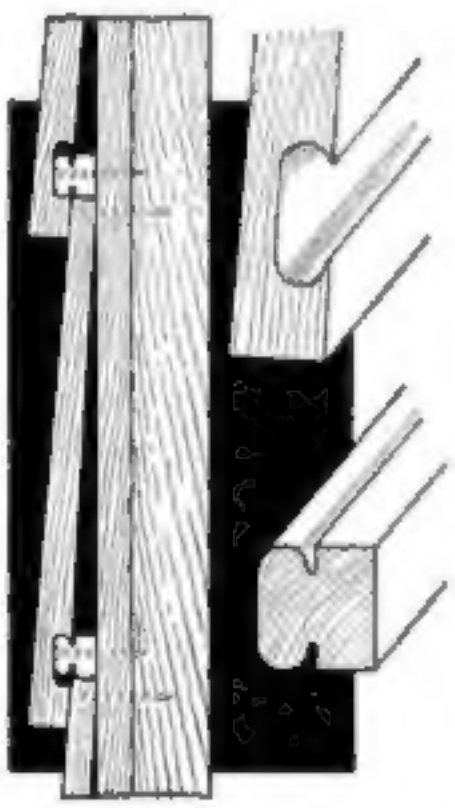
TO SLOW a plane for a landing in restricted space, James G. Ray, of Hatboro, Pa., offers an "air brake" of startlingly novel design. Projecting behind the tail assembly, a propeller-shaped ap-



pendage normally is held stationary, with its vanes set in the direction of air flow. In landing, the pilot releases the brake and the rotor, whose vanes now turn to catch the air, begins to revolve. Force required to turn the rotor acts as a drag upon the plane and allows it to settle slowly to earth, the inventor declares. . . . TROUBLESOME VIBRATION from automobile engines, refrigerators, washing machines, and industrial machinery of all kinds is said to be suppressed through a new system developed by George A. Rubissow of New York City. In principle, his plan is illustrated in the bottom view, which shows a base support for a stationary machine. Instead of using a single layer of elastic material to cushion vibrations, he employs two layers, sandwiching a heavy slab of lead or stone between them. The inertia or resistance to motion of this slab, he maintains, largely absorbs vibrations that otherwise would be transmitted to the floor. This anti-vibration scheme can be adapted to objects of many shapes, such as the automobile steering wheel pictured. For the heavy layer, the inventor suggests such alternative materials as ordinary gray cast iron, and mixtures of mercury or bronze with other metals. The cushioning layers could be made of rubber, felt, hair, metal

shavings of springlike effect, sawdust, cork, or wool. . . . GOLFERS MAY TAKE A TIP from professionals, to get extra length in their drives, with a portable heater invented by W. D. Hampton, of Greensboro, N. C. Knowing that a ball at summer temperature will have a flight 20 to 25 yards longer than that of the same ball at 30 degrees, the "pro" warms his golf balls in a bowl of hot water in the locker room before use. To accomplish the same purpose, a new portable heater may be attached to a golf bag or carried separately. The balls are kept in a tubular screen container, nearly surrounded by a heating pad of chemical type. When water is added the chemicals give off steady heat, providing a supply of warmed balls throughout an entire day of play. Slits in the flexible bottom provide for inserting a ball, and a heated one may be removed by sliding back a cover at the top, as illustrated. . . . AN IMPROVED VARIETY OF SIDING for exterior walls has been devised by H. T. Seymour, of Easton, Md. In applying standard siding with nails spaced 16 to 24 inches apart, he points out, exposure to the elements eventually produces cracks spreading from the nail holes. Therefore he substitutes a special type of siding, whose inner side is grooved to interlock with a nailing strip. When these are secured and joined, as illustrated, each length of siding receives double support, at top and bottom. Moreover the scheme leaves no exposed nail holes, preventing attack by sun, wind, and rain, and offering a more sightly appearance.





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